Automatic Control Equipment

LT AUTOMATIC CONTROL EQUIPMENT

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CONTENTS

Note.—This book is made up of separate parts, or sections, as indicated by their titles, and the page numbers of each usually begin with 1. In this list of contents the titles of the parts are given in the order in which they appear in the book, and under each title is a full synopsis of the subjects treated.

LT AUTOMATIC CONTROL EQUIPMENT

KEY TO COLOR PLATES

Red	*Main-Reservoir Pressure*
Pink	*Brake-Cylinder Pressure*
Dark Green	*Pressure-Chamber Pressure*
Blue Green	*Feed-Valve Pressure*
Light Green	*Equalizing-Reservoir Pressure*
Orange	*Atmospheric Pressure*
Yellow	*Brake-Pipe Pressure*
Blue	*Live Steam*
Purple	*Application-Chamber Pressure*
Gray	*Reducing-Valve Pressure*

L T AUTOMATIC CONTROL EQUIPMENT

Serial 1537 Edition 2

INTRODUCTION

1. The new and improved locomotive and tender brake described here is known as the **L T automatic control equipment,** the letters *L T* being an abbreviation for locomotive and tender.

The L T automatic control equipment is adapted for all classes of engines and for all kinds of service, the only difference in the equipment for locomotives of different size or for different service being in the size of the brake cylinders used. It can be applied to any locomotive, whether used in high-speed or in ordinary passenger service, double-pressure-control service, freight service, or any kind of switching service.

2. This brake equipment differs materially from the older forms of locomotive brake equipment. It consists of less apparatus, as many of the valves are replaced by others of different construction, and the method of its operation is somewhat different. The same air pump, main reservoirs, duplex gauge, and brake cylinders, together with their apparatus for carrying the power to the brake shoes, are left in service, but the older forms of automatic brake valve and duplex governor are replaced by new ones; also, an improved form of the independent brake and release valve takes the place of the older form of straight-air brake valve.

The automatic control valve replaces the triple valves, auxiliary reservoirs, and high-speed reducing valves formerly used on the engine and tender, and a new form of pressure

controller fitted with the regulating device adapted for a quick change of pressures is used. The single pressure controller for the independent brake valve also acts as a reducing valve for the air-signal system, so that the style of reducing valve formerly used with the signal system is dispensed with. The double check-valves used with the combined automatic and straight-air brake are also used with in the L T equipment.

3. The L T equipment has all the advantages of the older types of brake equipment and many other important advantages found by practical experience to be necessary in modern locomotive brake service. The locomotive brakes can be graduated on or off, as desired, or they can be applied with a graduated, a full-service, or an emergency application. They can be applied and released in conjunction with the brakes on the cars or independently of them, and they can be released either wholly or partly, at the will of the engineer. Also, it is possible to release the train brakes and hold the locomotive brakes applied full force. When double-heading, the brake on either locomotive can be applied or released by the engineer on that engine without affecting any other brake. This is a valuable feature, because it permits the engine brake to be released in case the drivers slide and applied again as soon as the wheels begin to turn.

One very important feature of the former automatic and straight air brake is part of the automatic control equipment, namely, maintaining the automatic and straight air brakes as two separate units, so that their operation can be independent of each other. If either the automatic or the straight air brake should become inoperative, the defective brake will therefore not interfere with the proper operation of the other brake. This is a feature of great value, as it is very necessary that a good brake always be available on the locomotive and tender, particularly when the locomotive is detached from the train.

4. The supply of air for the locomotive brake cylinders during automatic brake application is taken direct from the main reservoir, and the automatic control valve is designed so as to supply automatically from the main reservoir any brake-

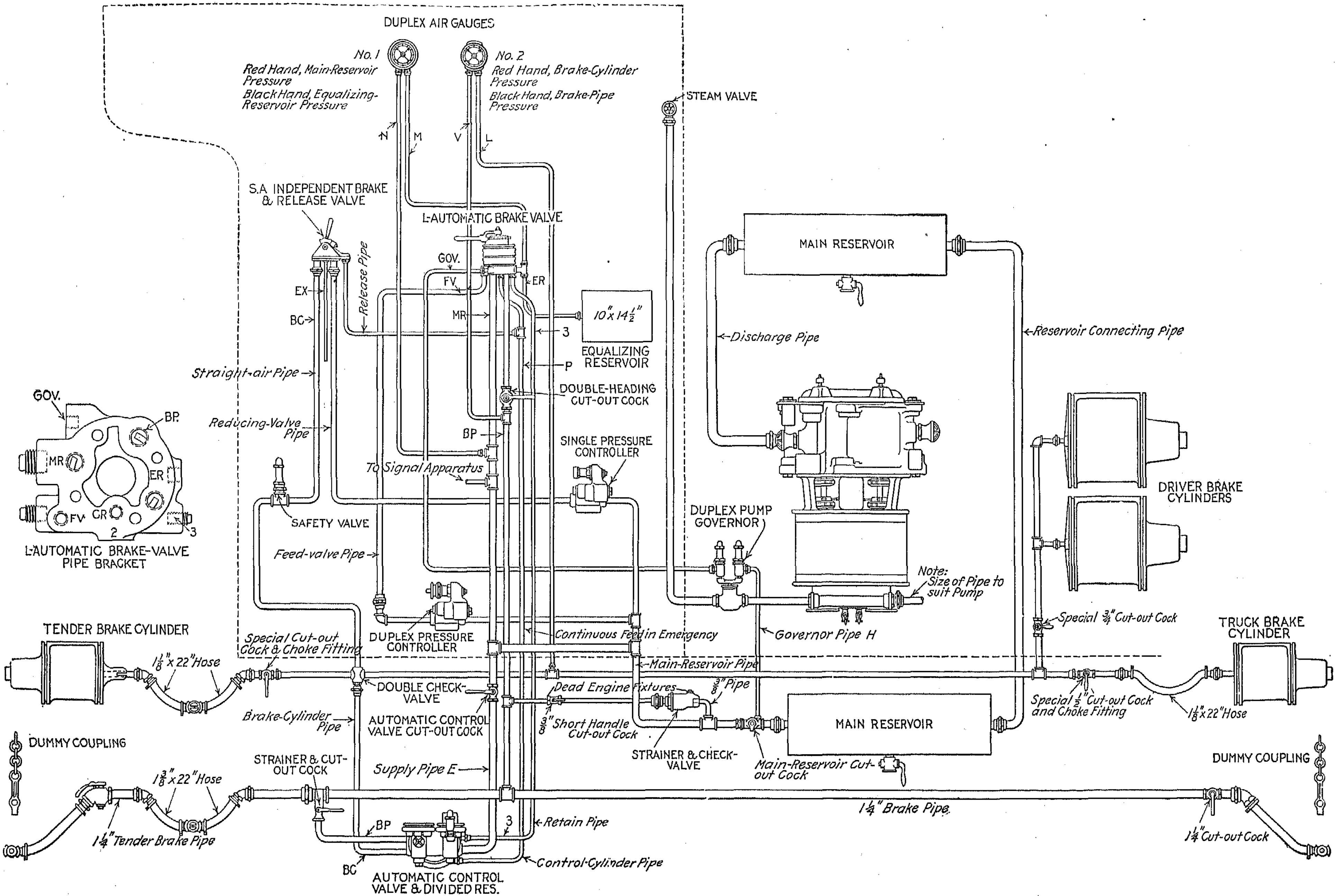
DUPLEX AIR GAUGES
No. 1
Red Hand, Main-Reservoir Pressure
Black Hand, Equalizing-Reservoir Pressure
No. 2
Red Hand, Brake-Cylinder Pressure
Black Hand, Brake-Pipe Pressure
N
M
V
L
STEAM VALVE
S.A INDEPENDENT BRAKE & RELEASE VALVE
L-AUTOMATIC BRAKE VALVE
GOV.
FV
ER
MR
EX
BC
Release Pipe
3
P
10" x 14½"
EQUALIZING RESERVOIR
MAIN RESERVOIR
Discharge Pipe
Reservoir Connecting Pipe
Straight-air Pipe
DOUBLE-HEADING CUT-OUT COCK
GOV.
BP.
MR
ER
FV
GR
2
3
L-AUTOMATIC BRAKE-VALVE PIPE BRACKET
Reducing-Valve Pipe
BP
To Signal Apparatus
SINGLE PRESSURE CONTROLLER
DRIVER BRAKE CYLINDERS
SAFETY VALVE
DUPLEX PUMP GOVERNOR
Feed-valve Pipe
Note: Size of Pipe to suit Pump
TENDER BRAKE CYLINDER
Special Cut-out Cock & Choke Fitting
DUPLEX PRESSURE CONTROLLER
Continuous Feed in Emergency
Governor Pipe H
Special ¾" Cut-out Cock
TRUCK BRAKE CYLINDER
1⅛" x 22" Hose
Main-Reservoir Pipe
DOUBLE CHECK-VALVE
Dead Engine Fixtures
⅜" Pipe
Special ½" Cut-out Cock and Choke Fitting
1⅛" x 22" Hose
Brake-Cylinder Pipe
AUTOMATIC CONTROL VALVE CUT-OUT COCK
⅜" Short Handle Cut-out Cock
MAIN RESERVOIR
DUMMY COUPLING
STRAINER & CUT-OUT COCK
1⅜" x 22" Hose
STRAINER & CHECK-VALVE
Main-Reservoir Cut-out Cock
DUMMY COUPLING
Supply Pipe E
1¼" Brake Pipe
BP
3
Retain Pipe
1¼" Tender Brake Pipe
1¼" Cut-out Cock
BC
Control-Cylinder Pipe
AUTOMATIC CONTROL VALVE & DIVIDED RES.

FIG. 1

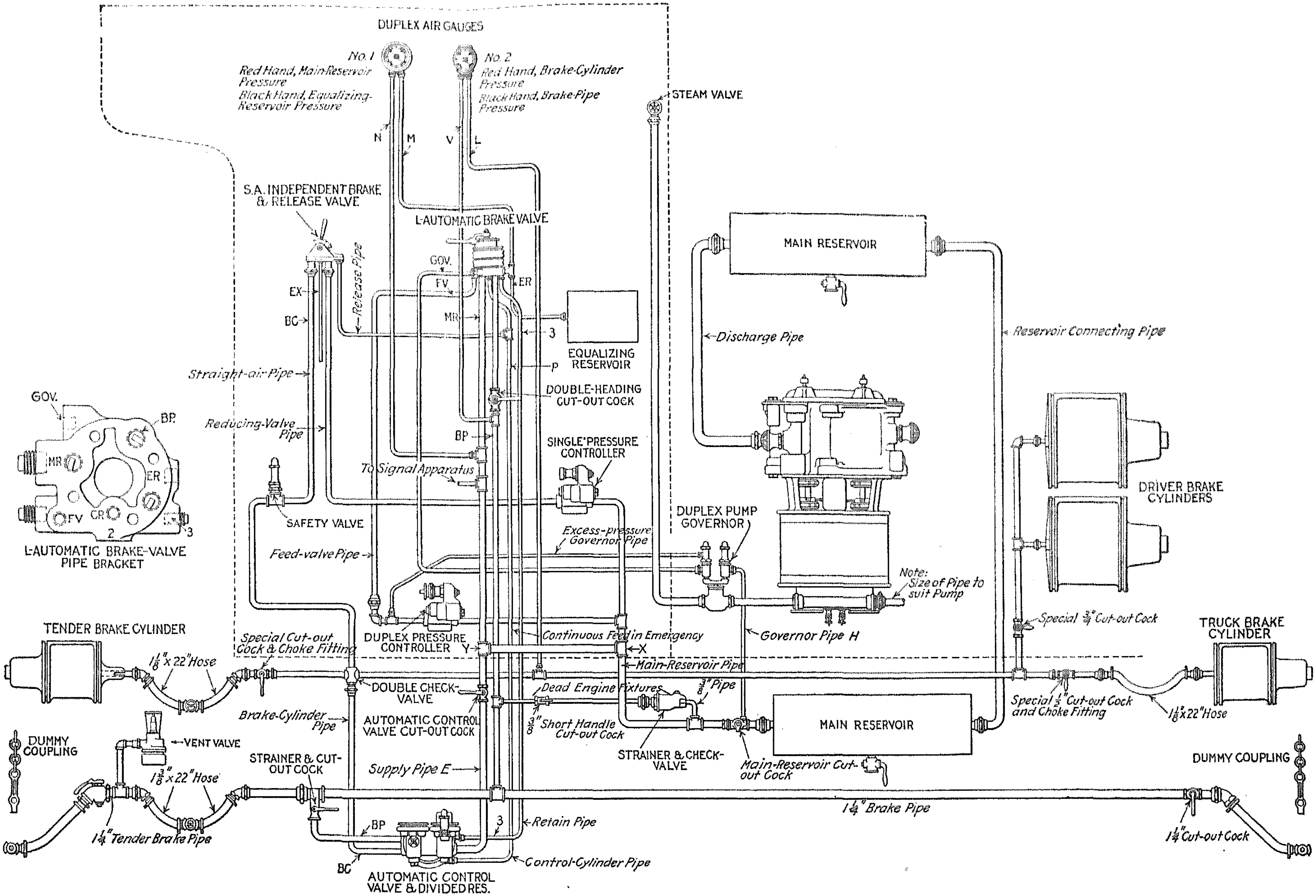

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Fig. 2

cylinder leakage, thus preventing the locomotive brakes from leaking off as they do when the brake-cylinder supply is taken from the auxiliary reservoir.

Neither the length of the brake-piston travel nor the brake-cylinder leakage affects the brake-cylinder pressure, and so long as the brake piston does not strike the non-pressure head of the cylinder or the brake rigging does not catch something that will prevent the power exerted on the piston from being transmitted to the brake shoes, the engine and tender brakes will be applied with the same pressure. If the brake is applied with the independent brake valve in order to prevent the engine from moving after being stopped, the brake valve should be left in service position, so that the brake will not leak off; and when standing on a down grade the locomotive brake can be applied independently to assist in holding the train while the auxiliaries throughout the train are being recharged.

PIPING ARRANGEMENT AND EQUIPMENT

GENERAL ARRANGEMENT OF APPARATUS

5. Schedules L T.—There are twelve schedules of the L T locomotive control equipment, designated L T 1 to L T 12. In general, the piping diagrams of these schedules are the same, the schedules differing only in a few details, as is shown in Table I.

It will be seen that the schedules differ in the style of duplex pump governor used, or in the presence or absence of a vent valve, a loss-of-pressure warning feature, or a quick-action cap for the automatic control valve.

6. The piping diagram of the schedule L T 1 equipment is shown in Fig. 1. This illustration shows the method of piping the style E duplex pump governor that is used in schedules L T 1, L T 2, L T 3, L T 4, L T 9, and L T 10. The high-pressure governor head is piped to the main-reservoir side of the main-reservoir cut-out cock, and is operated by main-

reservoir pressure. The low-pressure governor head is piped to the governor connection *Gov.* of the type L automatic brake valve, Figs. 1 and 2.

A safety valve is placed in the brake-cylinder pipe *B C*, Fig. 1, between the independent brake valve and the automatic control valve, its function being to prevent the brake-cylinder pressure obtained by a straight-air application from building

TABLE I

L T SCHEDULE DESIGNATORS, AND PARTS FOR EACH SCHEDULE

Schedule Number	For Road Engine	For Switch Engine	Duplex Pump Governor Style E	Duplex Pump Governor Style E X	Loss of Pressure Warning Features	Vent Valve	Quick-Action Cap
1	0	1	1	0	0	0	0
2	1	0	1	0	0	1	0
3	1	0	1	0	1	0	0
4	1	0	1	0	1	1	0
5	1	0	0	1	0	0	0
6	1	0	0	1	0	1	0
7	1	0	0	1	1	0	0
8	1	0	0	1	1	1	0
9	1	0	1	0	0	0	1
10	1	0	1	0	1	0	0
11	1	0	0	1	0	0	1
12	1	0	0	1	1	0	0

up beyond the desired amount (50 pounds) in the event of the single-pressure controller getting out of adjustment.

7. The piping diagram of the Schedule L T 6 equipment is shown in Fig. 2. This diagram illustrates the method of piping the style *E X* duplex pump governor, that is used in schedules L T 5, L T 6, L T 7, L T 8, L T 11, and L T 12. The high-pressure head is piped as in Fig. 1. The excess-pressure

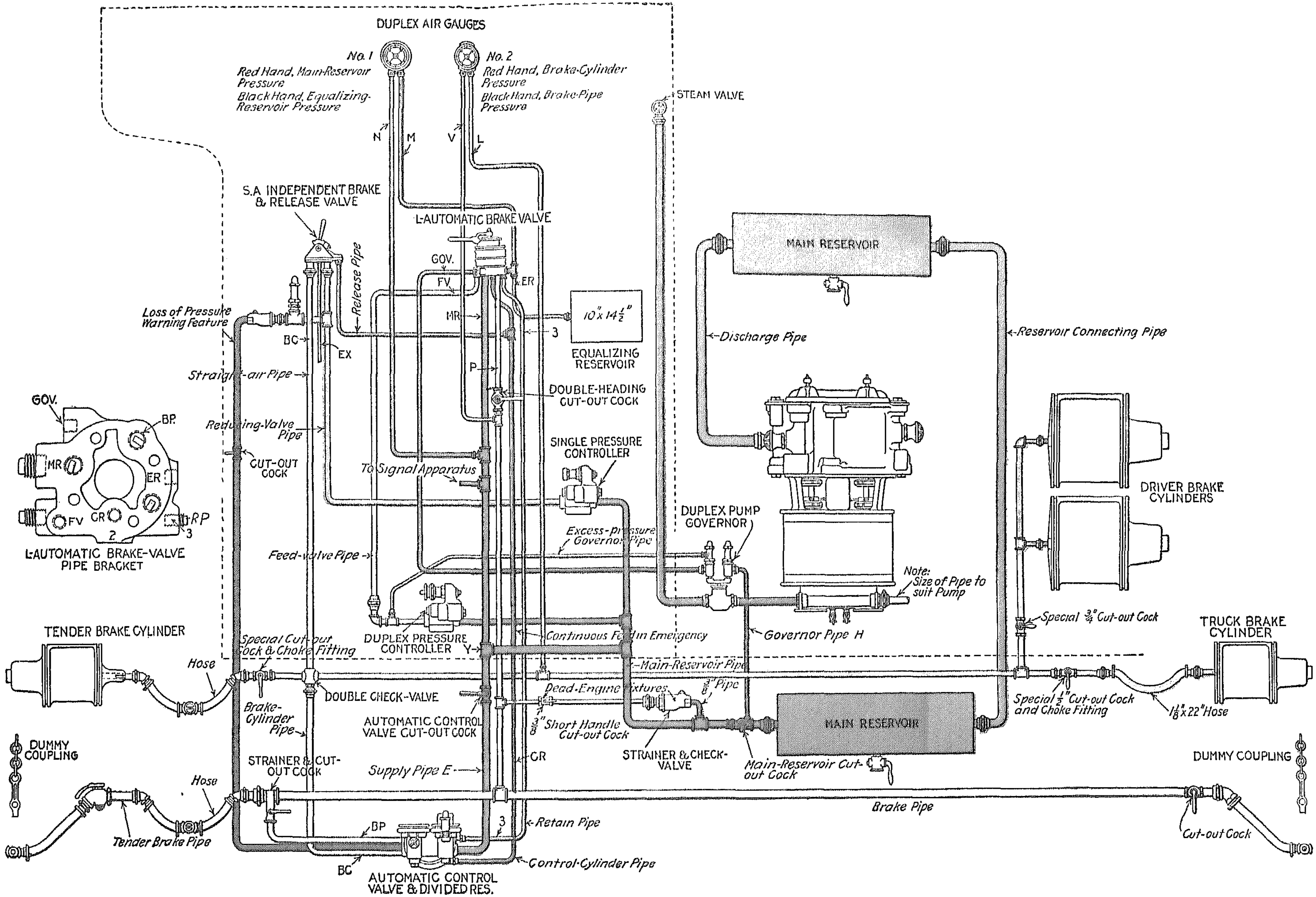

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Fig. 3

governor head has one pipe to the governor connection *Gov.* of the brake valve, and another pipe to the feed valve pipe *Fv.*, Fig. 2.

This illustration also shows a vent valve in the tender automatic-brake pipe, a vent valve being used with schedules L T 2, L T 4, L T 6, and L T 8.

8. The piping diagram of the schedule L T 12 is shown in Fig. 3, which illustrates the method of piping for the *loss-of-pressure warning feature*. This feature includes a pipe from the reducing-valve pipe *M R* to the auxiliary reservoir of the automatic control valve, in which there is a safety valve set at 50 pounds and a strainer and a check-valve. The safety valve replaces the one that is in the brake-cylinder pipe *BC* of the other equipments. This warning feature is included in schedules L T 3, L T 4, L T 7, L T 8, L T 10, and L T 12.

9. **Piping and Apparatus.**—The names and functions of the different pipes and pieces of apparatus of the L T equipment, as shown in Figs. 1 to 3, are as follows:

The *discharge pipe* conveys the compressed air from the air pump to the first main reservoir.

The *reservoir connecting pipe* connects the two main reservoirs.

The *main-reservoir pipe* leads from the second main reservoir and serves as a supply pipe to deliver full main-reservoir pressure to the automatic brake valve, the automatic control valve, the duplex-pressure controller, the single-pressure controller, the maximum-pressure governor head, and the red hand of the large air gauge.

The *main-reservoir cut-out cock* is placed in the main-reservoir pipe so that main-reservoir air can be shut off from the brake system when it is necessary to remove any of the apparatus while the brake system is charged. It contains a small bleed hole that allows the air to escape from the piping to the atmosphere when the cock is closed.

The *governor pipe H* is connected to the main-reservoir side of the main-reservoir cut-out cock and leads to the maximum-pressure head of the duplex pump governor, so that this head of

the governor is always subjected to main-reservoir pressure regardless of whether the cock is opened or closed.

The *supply pipe E* conveys main-reservoir air from the main-reservoir pipe to the automatic control valve for use in the locomotive brake cylinders. The *automatic control valve cut-out cock* in the supply pipe *E* is for the purpose of cutting off the supply of main-reservoir air from the automatic-control valve when necessary.

The *gauge pipe N* leads from the main-reservoir pipe to the red hand of the No. 1 air gauge, which registers main-reservoir pressure.

The *brake pipe* connects with the brake pipe on the cars of the train, so that it is in direct communication with all triple valves on the cars in the train. It connects with the automatic brake valve through the pipe *P*, and with the automatic control valve through the pipe *B P*.

The *double-heading cock* (in the brake pipe just under the automatic brake valve) is for the purpose of cutting out the automatic brake valve from the brake pipe on the following locomotive of a double-header. It is closed when its handle is parallel with, and open when its handle is at right angles to, the pipe.

The *dead engine fixtures*, or *by-pass for charging a dead engine*, consists of a pipe leading from the brake pipe *P* to the main-reservoir pipe, together with a cut-out cock, a strainer, and a non-return check-valve. The purpose of this arrangement is to provide a means of supplying air for the automatic control valve and brake cylinders of a dead engine (or one with a disabled air pump) from the supply in the brake pipe that is furnished by the other engine. When necessary to use the by-pass arrangement, the double-heading cock in the brake pipe must be closed and the cut-out cock in the by-pass pipe opened. When the by-pass arrangement is not in use, the cut-out cock in the by-pass pipe must be closed.

The *brake-cylinder pipe* leads from the automatic control-valve connection *B C* to the driver and tender brake cylinders; also, it connects with the engine-truck brake cylinder when the engine is provided with a truck brake.

The *driver*, *tender*, and *truck-brake cut-out cocks* are for the purpose of cutting out their respective brakes in case the brake becomes disabled.

The *choke fittings* in the tender and truck brake-cylinder pipe have a restricted opening that will allow air to pass to and from the engine-truck and tender-brake cylinders fast enough to operate their brakes properly; but if the hose connections to these cylinders should burst or become uncoupled, the choke fitting will restrict the flow of air so that the distributing valve can hold the pressure up to the standard in the other brake cylinders; hence, the bursting of a tender- or truck-brake hose will not disable all the locomotive brakes during the stop.

The *duplex pressure controller* reduces the main-reservoir pressure to the standard desired for use in the train brake pipe, and provides a means of quickly and easily changing brake-pipe pressure from the low standard to the high standard, or vice versa.

The *single-pressure controller* reduces the main-reservoir pressure to 40 pounds for the use of the independent brake; also, for obtaining the required air signal pressure on passenger engines, when so desired.

The *feed-valve pipe F V* leads from the duplex pressure controller to the pipe bracket of the automatic brake valve and conveys air at duplex controller pressure to the automatic brake valve.

The *excess-pressure governor pipe* leads from the feed-valve pipe to the chamber above the diaphragm in the excess-pressure head of the style *Ex.* duplex governor.

The *reducing-valve pipe* conveys air at a pressure of 40 pounds from the single pressure controller to the independent brake valve.

The *gauge pipe L* conveys air from the brake-cylinder pipe to the red hand of the No. 2 duplex gauge, which thus registers the pressure in the locomotive brake cylinders.

The *governor pipe Gov.* leads from the pipe bracket of the automatic brake valve to the chamber below the diaphragm in the excess-pressure head of the style *Ex.* duplex governor. It supplies air at the main-reservoir pressure to this chamber

when the automatic brake valve is in release, running, or holding position.

The *gauge pipe V* is connected to the brake pipe below the double-heading cock and leads to the black hand of the No. 2 duplex gauge. The black hand of this gauge therefore registers brake-pipe pressure at all times, whether the double-heading cock is open or closed.

The *equalizing-reservoir pipe* connects chamber *D* of the automatic brake valve to the equalizing reservoir.

The *gauge pipe M* leads from the equalizing-reservoir connection of the brake valve to the black hand of the No. 1 duplex gauge. The black hand of this gauge therefore registers equalizing-reservoir pressure at all times.

The *control-cylinder pipe* connects the automatic brake valve and the release pipe with the control cylinder of the automatic control valve.

The *release pipe* leads from the control-cylinder pipe to the release valve of the independent brake valve.

The *retain pipe* connects the automatic brake valve with the automatic control-reservoir exhaust port.

The *continuous feed in emergency pipe* connects the automatic brake valve and the release pipe of the independent brake and release valve with the control reservoir of the automatic control valve.

The *automatic brake valve* is for the purpose of operating the locomotive and train brakes.

The *independent brake and release valve* is for the purpose of operating the locomotive brakes only.

The *automatic control valve* controls the flow of air to and from the locomotive brake cylinders during automatic application of the brake, but not during independent applications. It is the most important feature of the L T equipment and takes the place of the engine and tender triple valves, their auxiliary reservoirs, and the high-speed reducing valves used with the former type of locomotive brake.

The *double check-valve* insures the operation of the straight-air brake under all conditions, regardless of the automatic control valve.

The red hand of the *No. 1 duplex air gauge* indicates main-reservoir pressure, and the black hand, equalizing-reservoir pressure.

The red hand of the *No. 2 duplex air gauge* indicates brake-cylinder pressure and the black hand, brake-pipe pressure.

TYPE L AUTOMATIC BRAKE VALVE

DESCRIPTION

10. The **type L automatic brake valve,** a side view of which is shown in Fig. 4, differs greatly in detail from previous

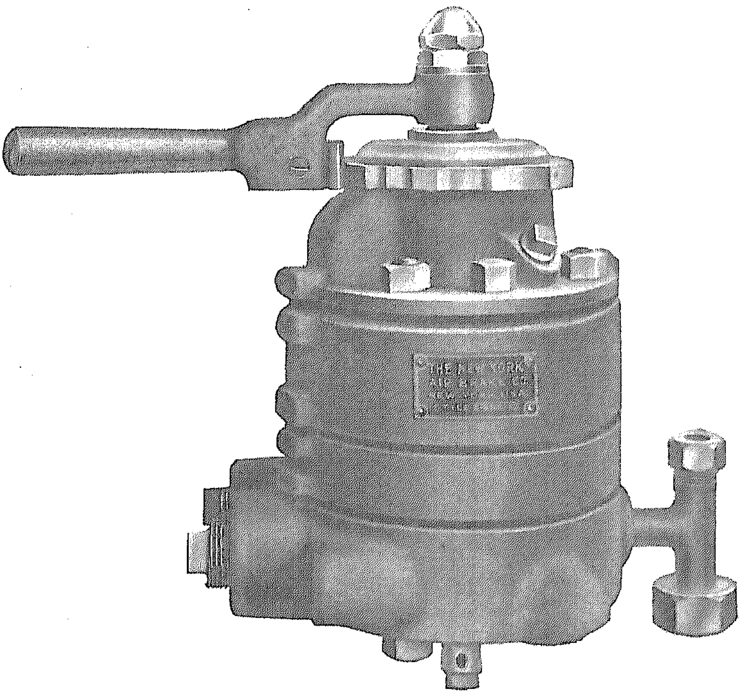


Fig. 4

styles of New York air-brake brake valves, as it not only performs all the functions of the other types of brake valves,

but also those functions necessary to obtain all the desirable operating features of the automatic control valve. All pipe connections are made to the pipe bracket to which the valve is fastened, so that the valve can be removed for repairs or replaced with another one without breaking any pipe connec-

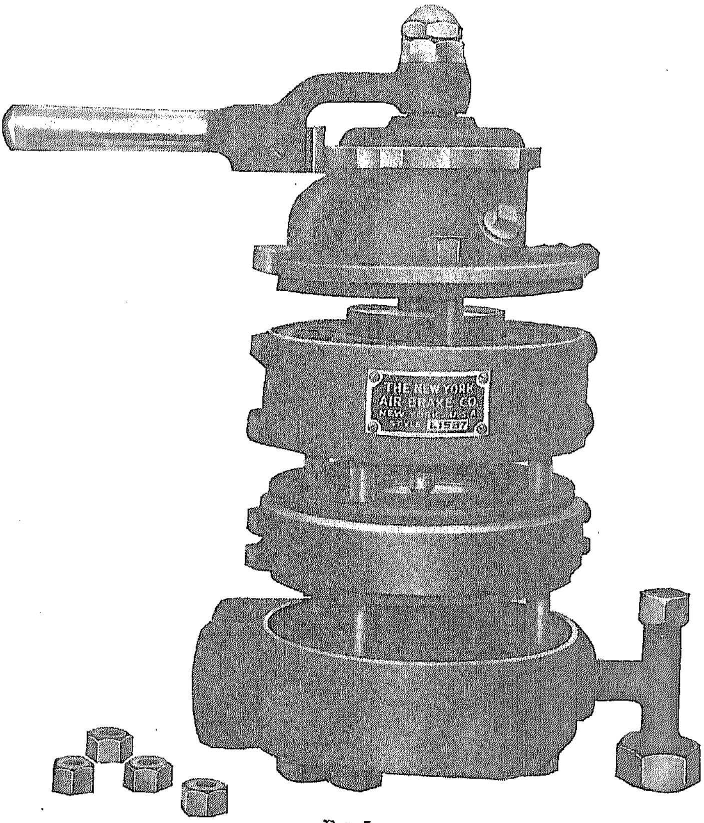


FIG. 5

tions. The support stud for carrying the valve is also a part of the pipe bracket. Lugs between which a wedge may be inserted when it is desired to separate the valve are cast on the sections of the valve, as shown in the illustration.

11. Fig. 5 shows the L automatic brake valve separated into its four parts. The top part is called the *top case;* the

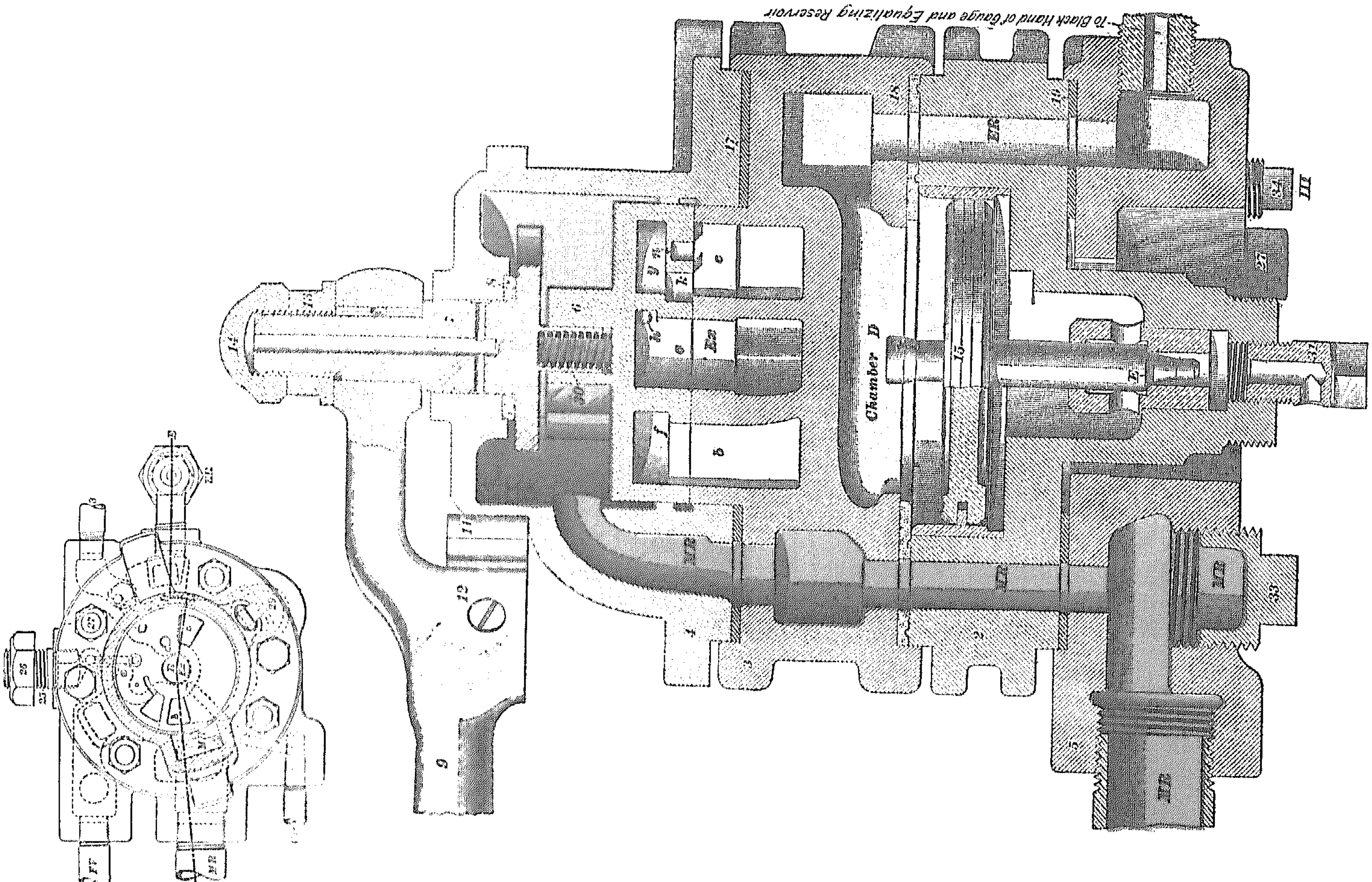
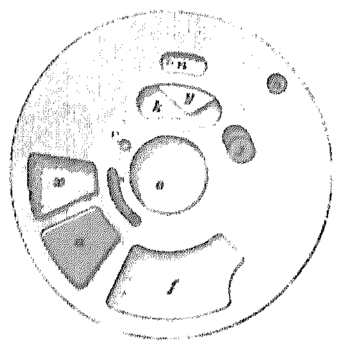


FIG. 6



BB519-8432 FIG. 8

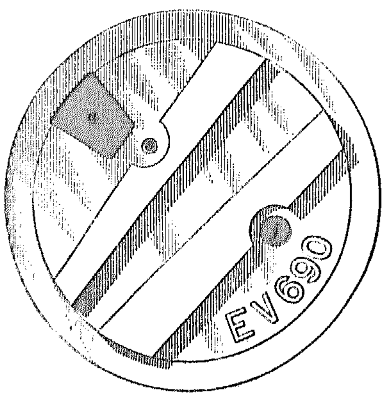


FIG. 7

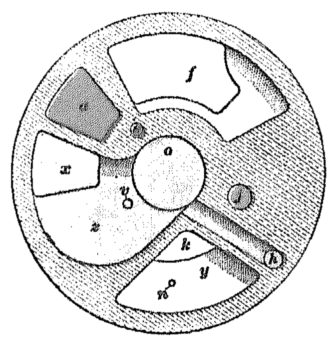


FIG. 9

part below that, the *rotary-valve seat;* the second part below, the *bottom case;* and the bottom part, the *pipe bracket.* The top case, rotary-valve seat, and bottom case are secured together by means of two capscrews. The pipe bracket contains all the pipe connections to the brake valve, and is provided with suitable ports and passages to convey the air from the pipes to the respective ports in the brake valve. It is secured to the brake valve by means of four bolts and nuts. The bolts pass entirely through the four parts of the valve and have the nuts on top. The brake valve, if desired, can be removed or changed by simply removing the four bolts and lifting the three upper sections off the pipe bracket. A new valve can be put back in its place and the pipe connections need not be disturbed.

12. Fig. 6 shows a side elevation of the valve sectioned vertically, bringing out as many details as possible. The reference line *A B C D E* through the small view above the side elevation shows the line on which the section is taken.

Fig. 7 shows a plan view of the rotary valve. This view illustrates the ports *a*, *j*, and *s*, which pass entirely through the valve, as well as the rotary-valve keyway.

Fig. 8 shows a view of the face of the rotary valve, illustrating the ports *a*, *j*, and *s* that pass entirely through the valve, the ports *h*, *n*, *v*, and *x*, the cavities *f* and *o*, and the grooves *n*, *s'*, and *k* in the face of the valve; also, it shows how groove *k* connects with cavity *y*.

Fig. 9 shows a sectional view of the rotary valve, illustrating the cavities and passages in the interior of the valve. The object of this view is to show the passage *z* leading from the exhaust port *x* to the exhaust cavity *o* and the manner in which port *h* is connected with cavity *o*; also, it shows how port *v* opens into passage *z*, and how port *n* opens into cavity *y*, which connects with groove *k*.

Fig. 10 shows the face of the rotary-valve seat, bringing out the location of the various ports and cavities in the valve seat. The groove extending from port *g* is for the purpose of forming a connection between port *v* in the rotary valve and port *g* when the rotary valve is in emergency position.

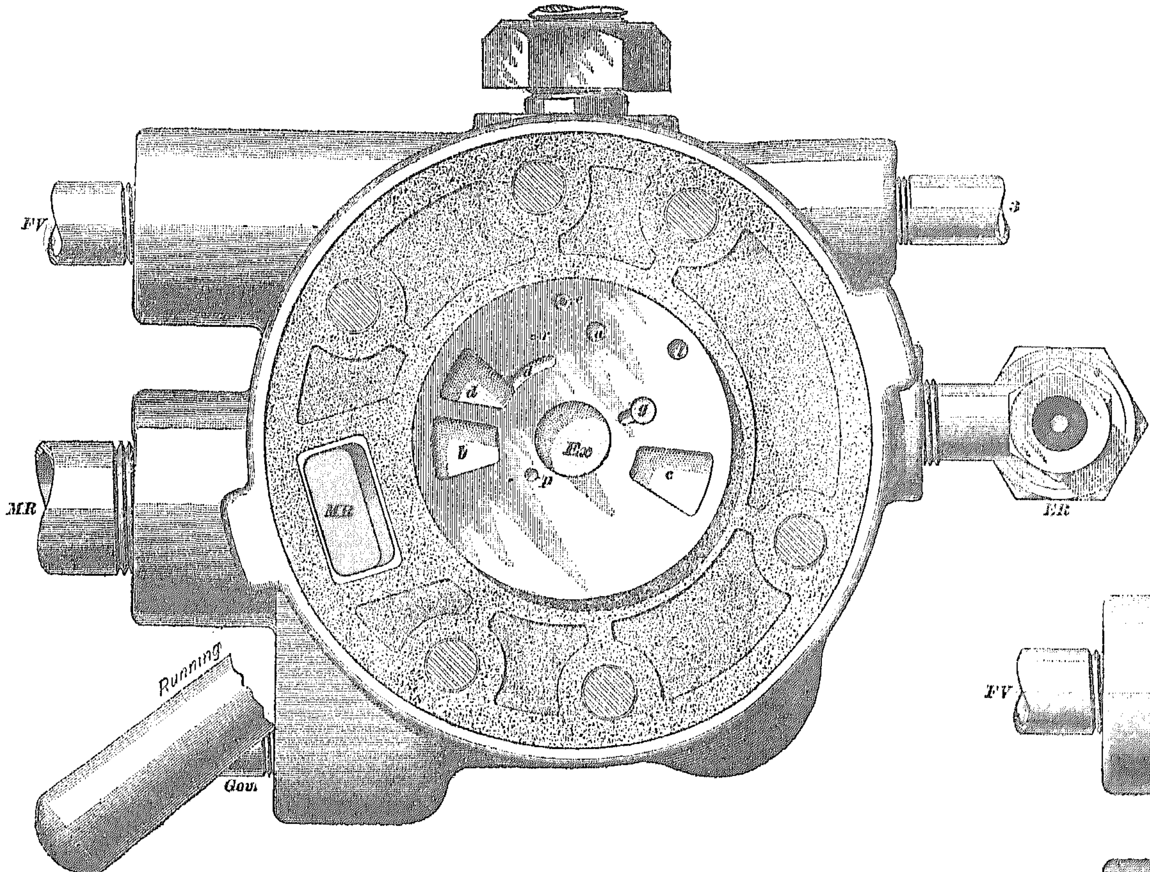
Fig. 11 shows a sectional view of the rotary-valve seat. The object of this illustration is to show how the passage *b–c* connects port *b* with port *c*, and with the brake-pipe port *B P*; how port *d* leads into the feed-valve port *F V*; how the exhaust port *E x* leads to the atmosphere; and how port *E R* leads into chamber *D*.

Fig. 12 shows a plan view of the pipe bracket *5* with the gasket *19* in place. The ports shown in this view lead to their respective pipe connections and register with the corresponding ports in the bottom case *2* of the brake-valve body.

Fig. 13 shows an upper section through the pipe bracket *5*, illustrating the various passages in the interior of the pipe bracket. The object of this illustration is to show the manner in which the ports in the face of the pipe bracket are connected to their respective pipe connections.

13. The names and numbers of the parts of the L brake valve, Fig. 6, are as follows: *2* bottom case; *3*, rotary valve seat; *4*, top case; *5*, pipe bracket; *6*, rotary valve; *7*, rotary-valve key; *8*, key washer; *9*, handle; *11*, handle latch; *12*, handle-latch screw; *13*, handle nut; *14*, handle locknut; *15*, equalizing piston; *17*, upper gasket; *18*, middle gasket; *19*, lower gasket; *25*, bracket stud; *26*, bracket-stud nut; *27*, bolt and nut; *29*, oil plug; *30*, rotary-valve spring; *31*, service-exhaust fitting; and *33* and *34*, pipe plugs.

The middle gasket *18* not only makes an air-tight joint between the rotary-valve seat and the bottom case, but also makes an air-tight joint over the equalizing piston *15* when the piston rises to the top limit of its travel during a service application. As this piston is forced firmly against the gasket, it prevents brake-pipe air from passing into chamber *D* and raising the pressure there, which would make the reduction less than was intended. The rotary-valve spring *30* holds the rotary key *7* up against the key washer *8*, and the rotary valve *6* on its seat during the time the brake valve is not charged with air pressure. The oil plug in the side of the top case, Figs. 4 and 5, can be removed and oil poured in around the edge of the rotary valve so that the oil will work under the


FV
3
MR
MR
d
b
Ex
g
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p
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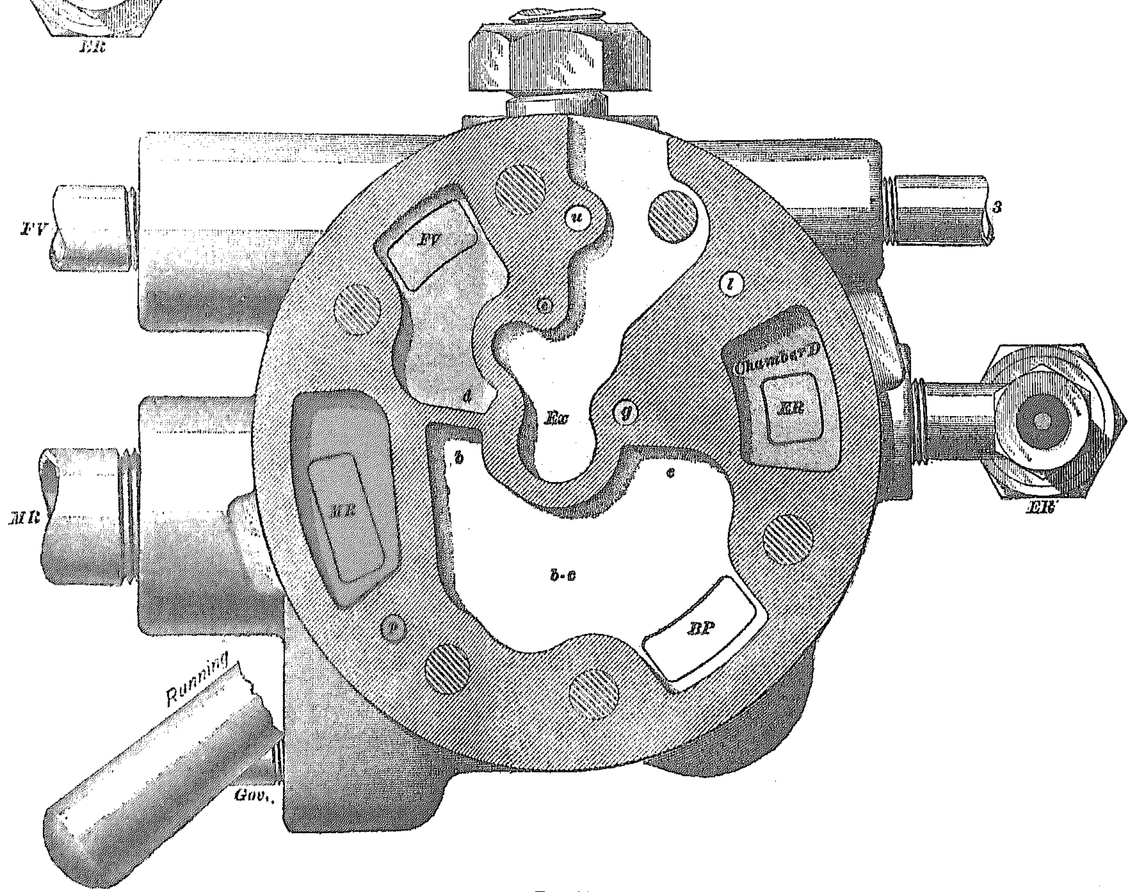
Running
Gov.

Fig. 10


FV
FV
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b-c
BP
ER
Running
Gov.

Fig. 11

face of the valve. The small oil hole shown in the rotary-valve key *7* provides a means of lubricating the rotary-valve key when the handle locknut *14* is removed.

14. As already mentioned, Fig. 8 shows the ports in the face of the rotary valve and Fig. 10 shows the ports in its seat. The exhaust port *E x* in the rotary-valve seat, Fig. 10, leads to the atmosphere, as shown in Fig. 11. The warning port *r*, Fig. 10, leads into the exhaust passage *E x*, so that when the brake valve is in release position, cavity *f* in the rotary valve, Fig. 8, connects port *d* of the seat with port *r*. The passage *b–c* in the rotary seat, Fig. 11, connects the ports *b* and *c* with port *B P*, which leads to the brake pipe *P*, Fig. 1. Port *d*, Fig. 11, connects with the feed-valve pipe through port *F V*, Figs. 11 and 13, and is connected with the brake-pipe port *b* by the cavity *f* in the rotary valve when the brake valve is in running and holding positions. Both the preliminary exhaust port *e* and the equalizing port *g*, Fig. 10, lead from the face of the rotary-valve seat into chamber *D*. Port *p* extends from the face of the rotary-valve seat to the governor-pipe connection *Gov.*, Fig. 13. Port *u* leads from the face of the rotary-valve seat to the control-reservoir pipe connection, Fig. 13, and port *l* extends from the face of the rotary-valve seat to the retain-pipe connection *S*, Fig. 13.

Port *j*, in the rotary valve, Fig. 8, extends directly through the valve and connects with port *g* in the valve seat, Fig. 10, when the brake valve is in release position, so that chamber *D* is charged up very quickly in release position. Port *j* also supplies main-reservoir air to port *d* when the brake valve is in lap, service, or emergency position. Port *a*, Fig. 8, extends directly through the rotary valve, and when the brake valve is in release position it registers with port *b* in the valve seat, Fig. 10, thus providing a large opening for main-reservoir air to pass to the brake pipe. The groove *k* in the face of the rotary valve, Fig. 8, extends into cavity *y* in the interior of the valve, Fig. 9. Groove *k*, Fig. 8, connects port *g*, Fig. 10, with the brake-pipe port *c* when the brake valve is in running and holding positions, thus equalizing chamber *D* and brake-

pipe pressures in these positions; also, it forms a connection between port *d* and cavity *y* when the brake valve is in emergency position. Port *h* in the rotary valve, Fig. 8, connects the preliminary-exhaust port *e*, Fig. 10, with the atmosphere through the exhaust cavity *o* and port *E x* when the brake valve is in service position. Port *h* also connects port *l* in the rotary-valve seat with the exhaust port *E x* when the brake valve is in running position, thus allowing the air that passes through the automatic control valve exhaust port and retain pipe to pass out to the atmosphere. Air from the automatic control valve exhaust port can pass to the atmosphere through these ports only when the automatic brake valve is in running position.

Port *x* in the face of the rotary valve, Fig. 8, connects with the passage *z*, Fig. 9, which leads into the exhaust cavity *o*. It is used in emergency position to discharge brake-pipe air from port *c* directly to the atmosphere. Port *v* in the rotary valve, Fig. 9, leads into passage *z*. It connects with the groove extending from the equalizing port *g*, Fig. 10, when the brake valve is in emergency position; thus, the air in chamber *D* and the equalizing reservoir can pass out to the atmosphere. The port *n* in the face of the rotary valve leads from groove *n* into cavity *y*, Fig. 9, and cavity *y* connects with groove *k*; thus, when the brake valve is in emergency position the main-reservoir air passes through port *j* in the rotary valve into port *d*, Fig. 10, thence through groove *d* into groove *k* in the face of the rotary, Fig. 8, and then into cavity *y* and out through port and groove *n* into port *u* in the rotary seat, Fig. 10, to the control-cylinder pipe connection, Fig. 13. Port *s*, Fig. 8, passes directly through the rotary valve and connects with groove *s'* in the face of the valve. When the brake valve is in release, running, or holding position, port *s* connects with port *p* of the valve seat and allows air at main-reservoir pressure to pass through pipe *Gov.*, Fig. 1. to the excess-pressure side of the duplex governor.

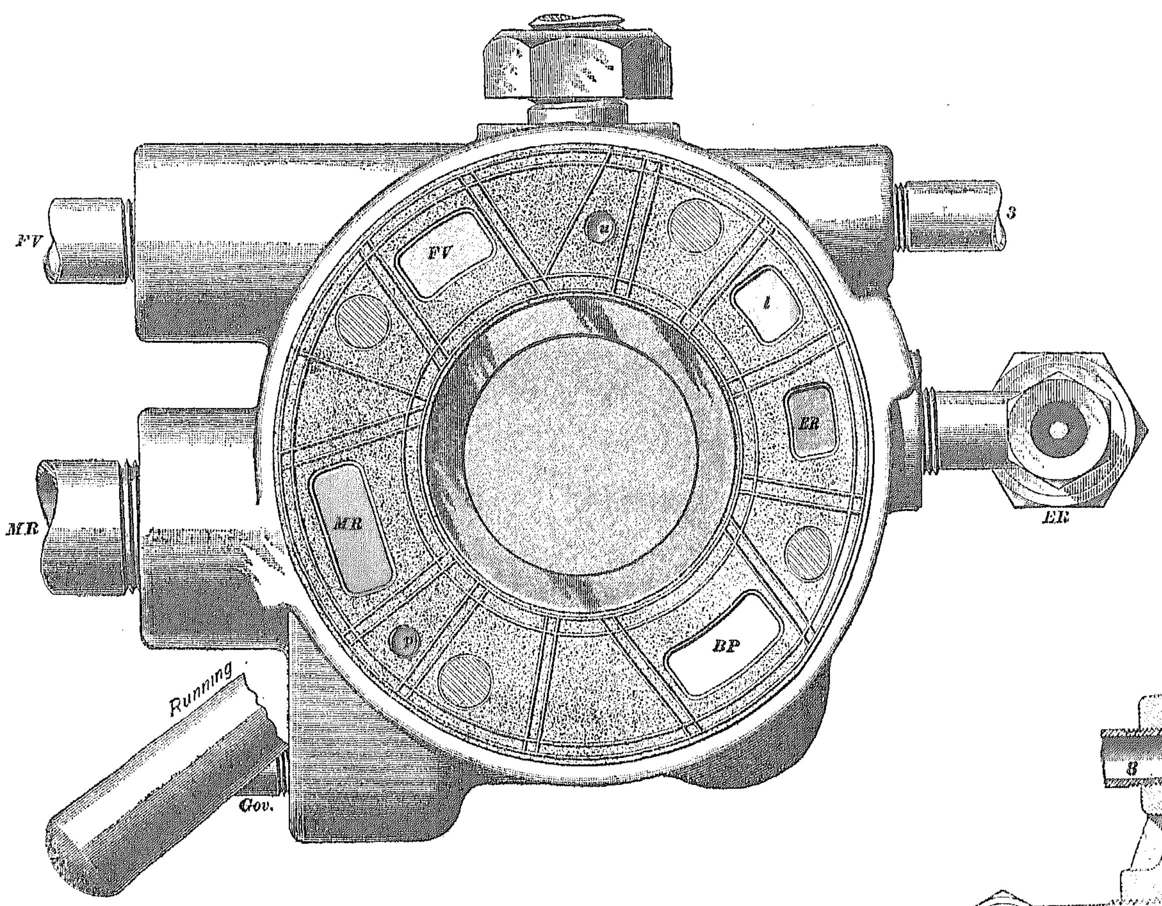

Fig. 12

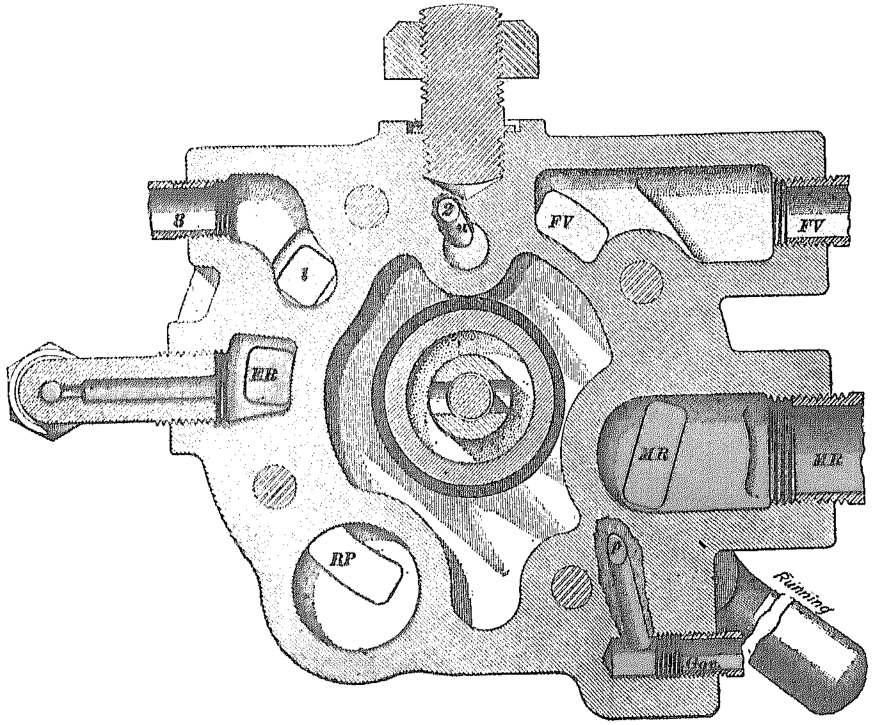

Fig. 13

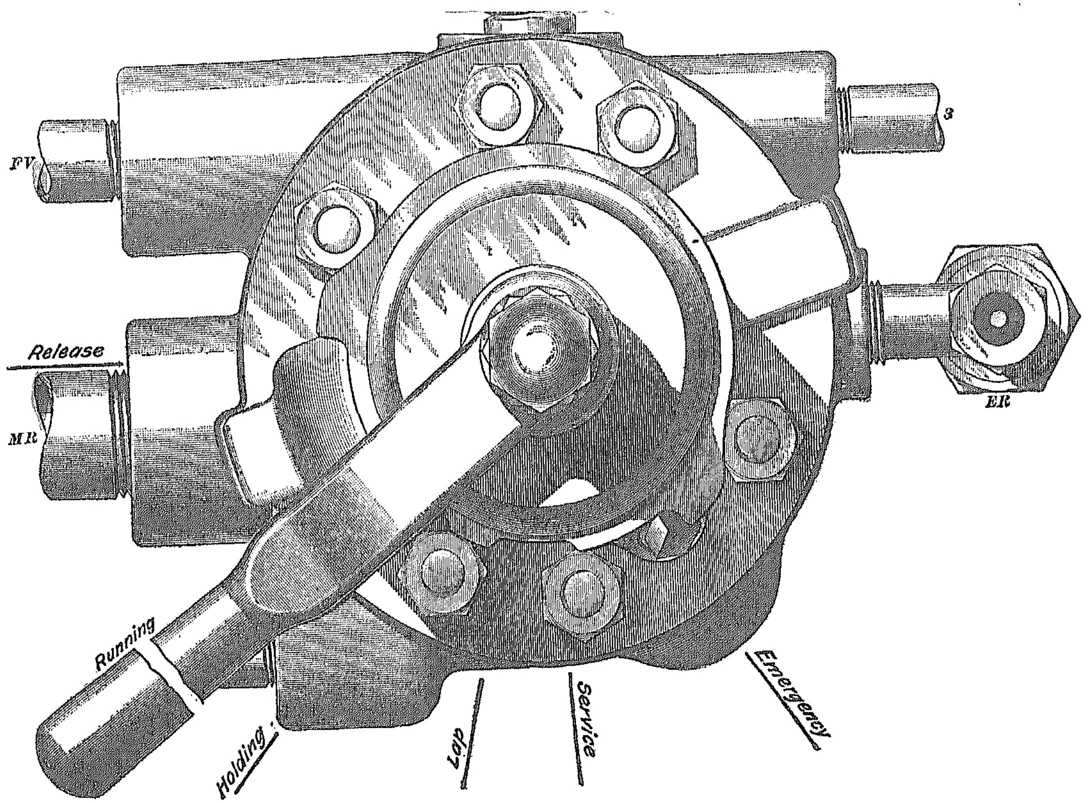

Fig. 14

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BRAKE-VALVE POSITIONS

15. The various positions of the rotary-valve handle of the type L brake valve are shown in Fig. 14, which is a view of the top of the brake valve with the handle in running position. There are six positions of the brake valve, as follows:

1. *Release position*, the purpose of which is to provide a large direct passage for main-reservoir air to flow rapidly into the brake pipe to release and recharge the train brakes quickly and without releasing the locomotive brakes, provided they are applied. When the brake valve is in this position, main-reservoir air at full pressure enters the brake valve at the fitting *M R* on the pipe bracket, Fig. 6, and passes up through the sections of the brake-valve body to the chamber over the rotary valve, which is maintained at main-reservoir pressure at all times.

2. *Running position*, in which the brake valve should be carried when the brake system is charged and the brakes are not being operated. In addition, this position is used to release the locomotive brakes through the automatic brake valve.

3. *Holding position*, which is used to hold the locomotive brakes applied by the automatic brake valve, if desired, while the train brakes are being released.

4. *Lap position*, which is used to blank all ports at the rotary valve, to hold the brakes applied between the reductions of brake-pipe pressure during a service application of the brakes, as well as to blank the ports in case the train breaks in two, a hose bursts, or the conductor's valve or an angle cock has been opened.

5. *Service position*, which is for the purpose of making gradual service applications of the brakes.

6. *Emergency position*, which is to be used when the brakes have to be applied suddenly and with full force.

OPERATION OF TYPE L BRAKE VALVE

16. In describing the operation of the brake valve, the various positions of the rotary-valve handle will be taken up in their regular order.

17. Release Position.—When the brake-valve handle is placed in release position, Fig. 15, the large supply port *a* in the rotary valve, Fig. 8, registers with port *b* in the rotary-valve seat, Fig. 10. This allows main-reservoir air at full pressure to pass through the large supply port *a* in the rotary valve into port *b* in its seat and then through passage *b–c*, Fig. 11, into the ports *c* and *B P*, thus charging the brake pipe from the main reservoir direct. Port *j* in the rotary valve, Fig. 8, also registers with the equalizing port *g* in the rotary-valve seat, Fig. 10, thus permitting main-reservoir air to pass directly into chamber *D* above the equalizing piston *15*, Fig. 6. This builds up the pressure in chamber *D* with that in the brake pipe, so that piston *15* does not rise and cause a discharge of air at the brake-pipe exhaust when releasing the brakes on a short train. As the air enters chamber *D* it can pass through passage *E R*, Fig. 6, to the equalizing reservoir and the black hand of the No. *1* duplex gauge, Fig. 1, so that the equalizing reservoir charges up at the same rate as chamber *D* and the black hand of No. *1* duplex gauge registers the pressure.

18. In release position, cavity *f* in the rotary valve, Fig. 8, connects port *d* and the warning port *r* in the rotary-valve seat, Fig. 10, and allows air at double-pressure control-valve pressure to pass from port *d* through cavity *f* and port *r* to the atmosphere through the exhaust port *E x*. The air in escaping makes sufficient noise to warn the engineer that the brake valve is in release position, so that he will not leave it there too long and thus overcharge the brake pipe. The double-pressure control valve cannot control the brake-pipe pressure when the brake valve is in release position; consequently, if the brake valve is left in release position too long, the brake pipe and auxiliaries will be charged up to the pressure in the main reservoir. Also,

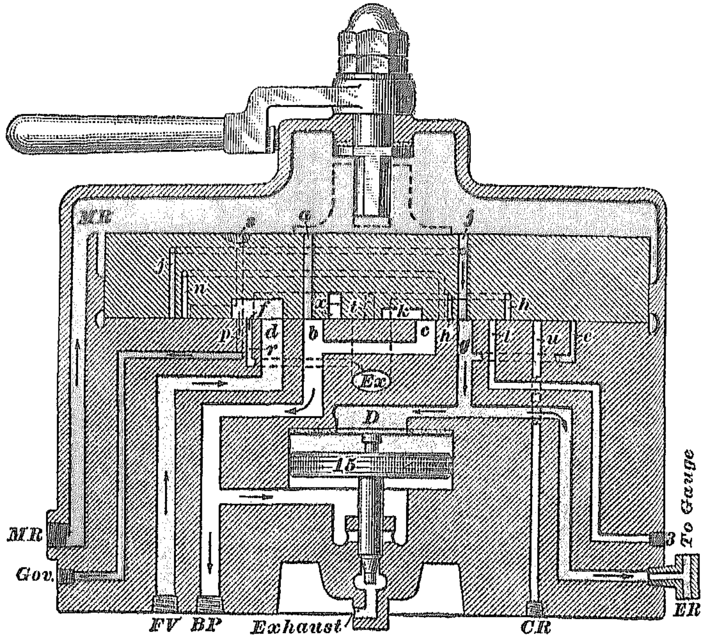

Fig. 15

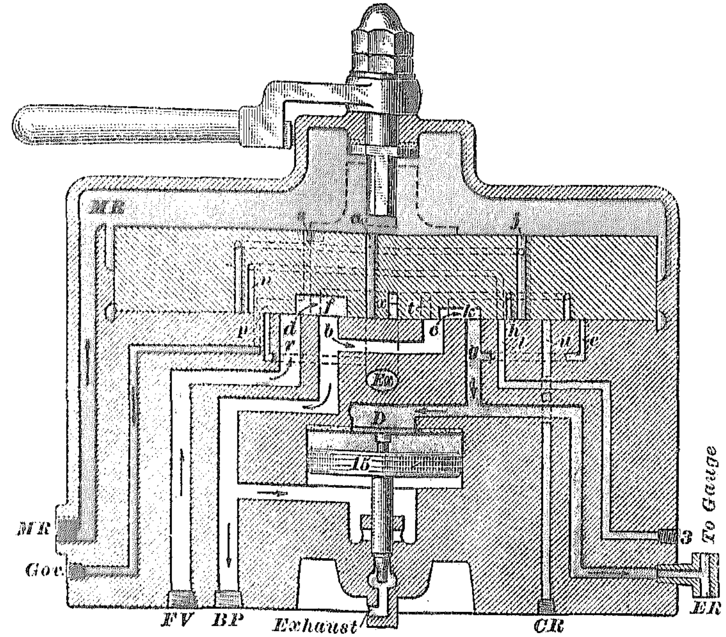

Fig. 17

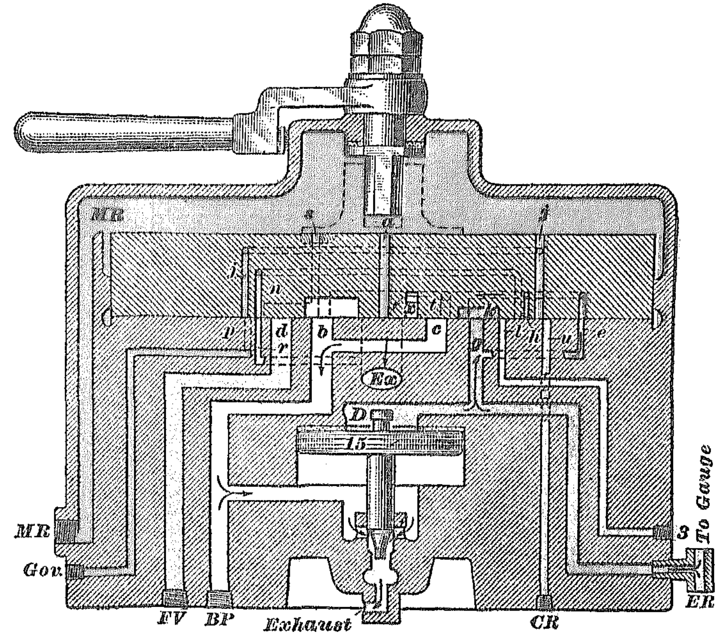

Fig. 19

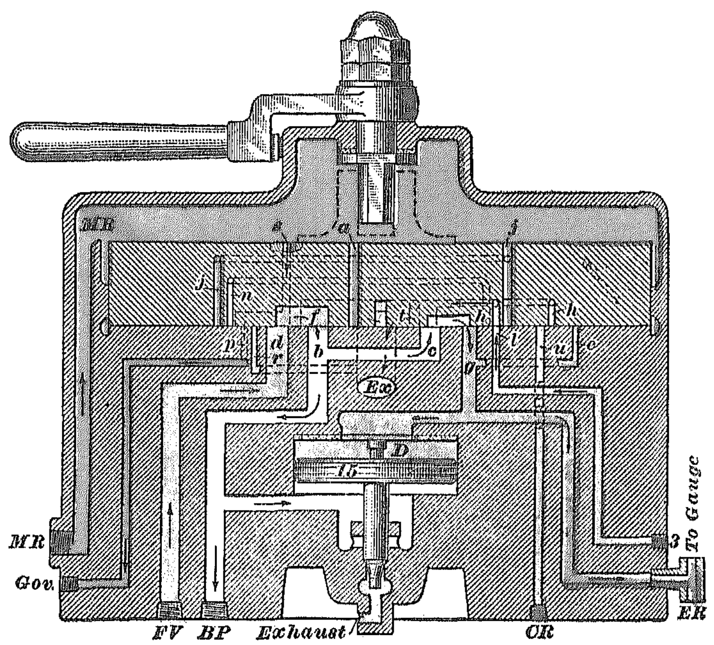

Fig. 16

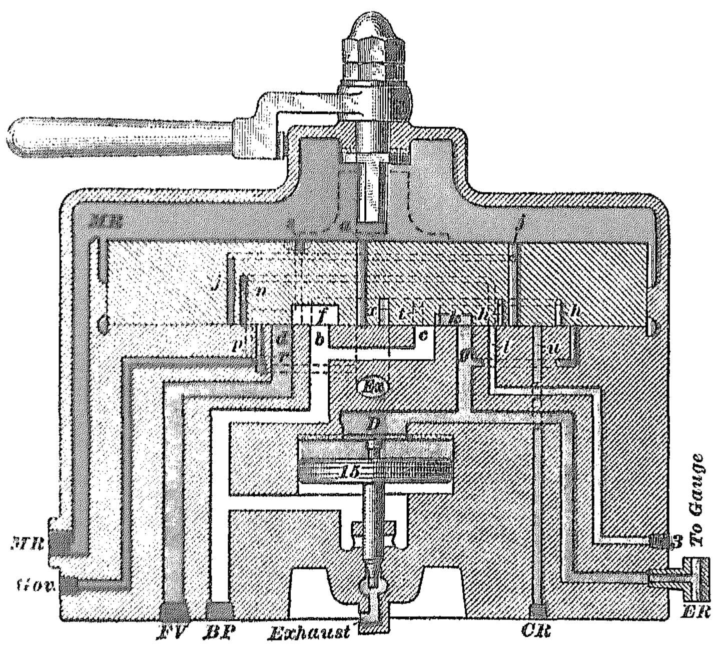

Fig. 18

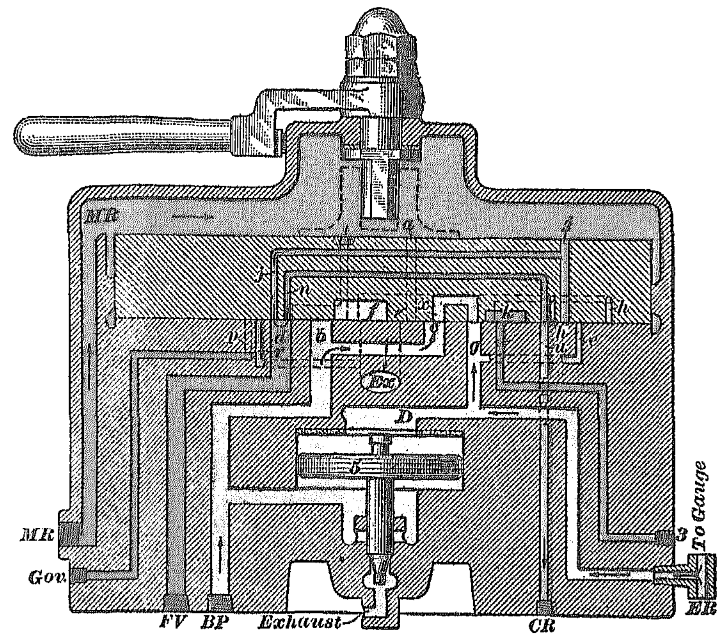

Fig. 20

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when the brake valve is moved to running or holding position, the pressure controller will be held closed by the high pressure in the brake pipe; consequently, the brakes will creep on as brake-pipe pressure is reduced by leaks. The groove *s′* in the face of the rotary valve, Fig. 8, connects port *s* with port *p* in the valve seat, Fig. 10, and allows main-reservoir air to flow to the chamber below the diaphragm in the excess-pressure head of the duplex governor; thus, with the brake valve in release position, main-reservoir air controls the pump through this side of the duplex governor.

In release position, port *h* in the rotary valve, Fig. 8, does not connect with port *l* in the valve seat, Fig. 10, and port *l* is closed, so that air from the automatic control-valve exhaust cannot escape through the automatic brake valve; consequently, the brakes on the train will be released, but the locomotive brakes will be held on unless the independent brake valve is moved to locomotive automatic release position. Port *l* is closed at all times except when the brake valve is in running position, and port *u* is closed at all times except when the brake valve is in emergency position.

19. Running Position.—In running position, Fig. 16, air from the main reservoir cannot pass directly into the brake pipe, nor through port *j*, Fig. 8, into chamber *D*, because port *a* in the rotary valve does not connect with port *b* in the rotary-valve seat, Fig. 10, and port *j* in the rotary valve is moved away from port *g* in the rotary-valve seat. Also, cavity *f* is moved away from the warning port *r*, so that no air passes through this port. Cavity *f* in the rotary valve connects port *d* with port *b*, so that air at double-pressure control-valve pressure enters the brake valve at the connection *F V* on the pipe bracket and flows through port *d*, cavity *f*, port *b*, and passage *b–c*, Fig. 11. into port *c* and port *B P* to the brake pipe. These ports and passages afford a large direct opening from the double-pressure control-valve pipe to the brake pipe, so that the brake pipe will charge up rapidly to the pressure for which the double-pressure control valve is adjusted. Also, groove *k* in the rotary valve, Fig. 8, connects the ports *c* and *g* in the

valve seat, Fig. 10, allowing brake-pipe air to pass through port *c*, groove *k*, and port *g* into chamber *D* and the equalizing reservoir, thus equalizing the pressures on both sides of the equalizing piston *15*. Brake-pipe air can go also by way of chamber *D* to the black hand of the No. *1* duplex gauge, Fig. 1; hence, in running position the black hand of this gauge will register brake-pipe pressure as well as chamber-*D* pressure. Port *h*, Figs. 8 and 9, in the rotary valve registers with port *l* in the valve seat, so that air from the automatic control-valve exhaust can pass through the retain pipe, Fig. 1, to the automatic brake valve, and then to the atmosphere through the ports *l* and *h*, cavity *o*, and the exhaust port *E x*. The automatic brake valve must be in running position and the automatic control valve must be in release position before the air in the control reservoir of the automatic control valve can pass to the atmosphere through the ports *l* and *h* in the automatic brake valve.

Port *s* in the rotary valve registers with port *p* in the valve seat, so that main-reservoir air flows through these ports into the pipe *Gov.*, Fig. 1, leading to the excess-pressure side of the duplex governor.

If the brake valve is in running position and the pump can pump air into the main reservoir faster than the air can flow through the duplex-pressure control valve into the brake pipe, or if a sufficient number of uncharged cars are cut in, or if, when a heavy brake application and release is made, the handle of the automatic brake valve is moved to running position too soon, there will be more difference between the main-reservoir and the brake-pipe pressure than the excess-pressure spring in the pump governor is set for. This will cause the governor to stop the pump until the difference in main-reservoir and brake-pipe pressure is reduced to an amount less than that for which the excess-pressure spring is set, when the governor will again start the pump.

20. Holding Position.—The holding position, Fig. 17, lies between the running and lap positions and is so named because, with the brake valve in holding position the locomotive

brakes can be held applied by the automatic brake valve while the train brakes are being released and recharged.

In this position, port *h* in the rotary valve is moved away from port *l* in the rotary-valve seat and port *l* is closed by the rotary valve; thus, no air can escape from the automatic control-valve exhaust through the automatic brake valve. This holds the air in the control reservoir of the automatic control valve, and the locomotive brake, if applied, remains applied. Cavity *f* in the rotary valve connects port *d* with port *b*, so that air at double-pressure control-valve pressure flows through port *d*, cavity *f*, and port *b* to the brake pipe. Groove *k* in the face of the rotary valve forms a connection between the ports *c* and *g* in the rotary-valve seat, and in this way chamber-*D* and the brake-pipe pressures are kept equal. Port *s* in the rotary valve also registers with port *p* in the rotary-valve seat, allowing main-reservoir air to pass to the excess-pressure side of the duplex governor, which controls the pump. The only difference between running and holding positions is that in running position port *l* in the rotary-valve seat is open to the exhaust, while in holding position it is closed. In either the running or the holding position, the train brakes are released and recharged.

21. Lap Position.—In lap position, Fig. 18, all ports leading to the main reservoir, brake pipe, chamber *D*, and the atmosphere are closed. Port *s* in the rotary valve is moved away from port *p* in the valve seat; thus, main-reservoir air is prevented from passing to the chamber under the diaphragm in the excess-pressure side of the duplex governor. In this way, the excess-pressure governor is prevented from operating to stop the pump, and the pump continues to work until the main-reservoir pressure is high enough to operate the high-pressure side of the governor. Port *l* in the rotary-valve seat is covered by the rotary valve, which prevents air from escaping from the automatic control-valve exhaust through the automatic brake valve. Port *j* in the rotary valve registers with groove *d* in the rotary-valve seat, which extends from port *d*, so that main-reservoir air passes through port *j*, groove *d*, and port *d* into the feed-valve pipe and through the excess-pressure governor pipe,

Fig. 2, to the top of the excess-pressure governor. This insures that this side of the duplex governor will not operate to stop the pump when the brake valve is in lap position.

The normal use of lap position is to blank all ports at the rotary valve between the reductions of brake-pipe pressure during a service application of the brakes, as well as to blank the ports in case the train breaks in two, a hose bursts, or the conductor's valve or an angle cock has been opened.

22. Service Position.—When the brake-valve handle is moved to service position, Fig. 19, port *j* in the rotary valve still registers with groove *d* in the rotary-valve seat and main-reservoir air passes to the chamber above the diaphragm in the excess-pressure head of the duplex governor, the same as in lap position. All other ports in the rotary valve and its seat are in the same relation to each other as in lap position, except that port *h* in the rotary valve registers with port *e* in the rotary-valve seat and chamber-*D* air escapes gradually through the restricted opening in port *e* into port *h*, thence to cavity *o*, and out to the atmosphere through the exhaust port *E x*. The equalizing reservoir, with a capacity of about 800 cubic inches, is connected to chamber *D* so as to increase the volume of chamber-*D* air and thus permit a graduated reduction to be made in chamber-*D* pressure. The discharge of air through the ports *e* and *h*, cavity *o*, and exhaust port *E x* reduces chamber-*D* pressure above the equalizing piston *15*, and as the brake-pipe pressure below piston *15* is then greater than that in chamber *D*, it forces the piston up; this, in turn, raises the brake-pipe exhaust valve *E*, Fig. 6, which is a part of the piston, and allows brake-pipe air to flow to the atmosphere through the brake-pipe exhaust port. The service-exhaust fitting *31*, Fig. 6, having a $\frac{9}{32}$-inch opening with a side outlet, is provided to graduate the flow of air from the brake-pipe exhaust.

23. When a service application is to be made, the brake-valve handle should be moved to service position and allowed to remain there until chamber-*D* pressure has been reduced

the desired amount. The reduction in chamber-*D* pressure is shown by the black hand of No. *1* gauge, Fig. 1. After this, the handle should be moved back to lap position, so as to stop the flow of air from chamber *D*. Brake-pipe air will continue to flow from the brake-pipe exhaust port until the pressure below piston *15* becomes slightly less than that in chamber *D*, when the pressure in chamber *D* will move the equalizing piston *15* down and close the brake-pipe exhaust valve *E*. With a very short train, the brake-pipe exhaust valve *E* will close at about the same time that the brake-valve handle is moved back to lap position. With a long train, however, there is a larger volume of brake-pipe air; consequently, the exhaust valve *E* will remain open longer and chamber-*D* pressure will slowly move the piston *15* down against the decreasing brake-pipe pressure, thus gradually and automatically closing the exhaust valve *E* when brake-pipe pressure is slightly less than that in chamber *D*.

If the brake valve is again placed in service position chamber-*D* pressure will be reduced; then, the equalizing piston *15* and the exhaust valve *E* will automatically make the same reduction in brake-pipe pressure. In this manner, the equalizing piston *15* and the exhaust valve *E* automatically reduce brake-pipe pressure the amount that the engineer reduces chamber-*D* pressure, regardless of whether the brake pipe is long or short.

24. Emergency Position.—When necessary to apply the brakes suddenly and with full force, the brake-valve handle is quickly moved to emergency position, Fig. 20. Port *x* in the rotary valve registers with port *c* in the rotary-valve seat, allowing brake-pipe air to pass through port *c* into port *x*, thence through passage *z* into cavity *o*, and out through the exhaust port *E x* to the atmosphere. These ports and passages provide a large opening from the brake pipe to the atmosphere, causing a sudden and heavy reduction in brake-pipe pressure. This, in turn, operates the automatic control valve and triple valves quick-action, so that all brakes are applied with a heavy cylinder pressure and in the quickest time possible.

Port *j* in the rotary valve registers with port *d* in the rotary-valve seat, and main-reservoir air passes into the feed-valve pipe and then through the excess-pressure governor pipe to the chamber above the diaphragm in the excess-pressure governor. Groove *k* in the face of the rotary valve connects with groove *d* in the rotary-valve seat, and port *n* in the rotary valve registers with port *u* in the rotary-valve seat. This allows main-reservoir air to pass through port *j* into port *d* and through groove *d* into groove *k*, thence through cavity *y*, ports *n* and *u*, and the control-cylinder pipe, Fig. 1, to the control reservoir of the automatic control valve. The opening through port *n* in the rotary valve is of such size as to allow main-reservoir air to pass to the control revervoir of the automatic control valve in about the same volume that it can pass from the control reservoir through the safety valve, which builds the control reservoir pressure up to about 50 pounds. Port *v* in the face of the rotary valve connects also with the groove extending from port *g* in the rotary-valve seat and allows chamber-*D* air to pass through ports *g* and *v* into passage *z*, Fig. 9, and then through cavity *o* and exhaust port *E x* to the atmosphere.

25. Double-Heading Precautions.—When double-heading, the engineers on the following engines must close the double-heading cock in the brake pipe under the automatic brake valve, Fig. 1, so as not to interfere with the proper handling of the train brakes from the leading engine. The automatic brake valve on the following engines must also be carried in running position in order to give the leading engineer control of the automatic control valves on these engines.

The independent brake valve handle should also be carried in release position when the independent brake valve is not in use.

C-2 INDEPENDENT BRAKE VALVE

DESCRIPTION

26. The **C-2 independent brake valve** is known as the *combined independent brake and release valve.* It is used with the L T locomotive brake and takes the place of the straight-air brake valve used with the previous types of locomotive brake equipment. It performs all the functions of the former types of straight-air brake valves, and in addition it enables the engineer to release the locomotive brakes when they have been applied and are being held on by the automatic brake valve. It enables the engineer also to apply and release the locomotive brakes, either partly or fully, independently of the operation of the train brakes and regardless of the position of the automatic brake valve. This gives the engineer better control of the locomotive brakes, because in heavy-grade service he can prevent the overheating of the driving-wheel tires and assist the pressure-retaining valves in holding the train while the auxiliaries are being recharged. This is done by placing the

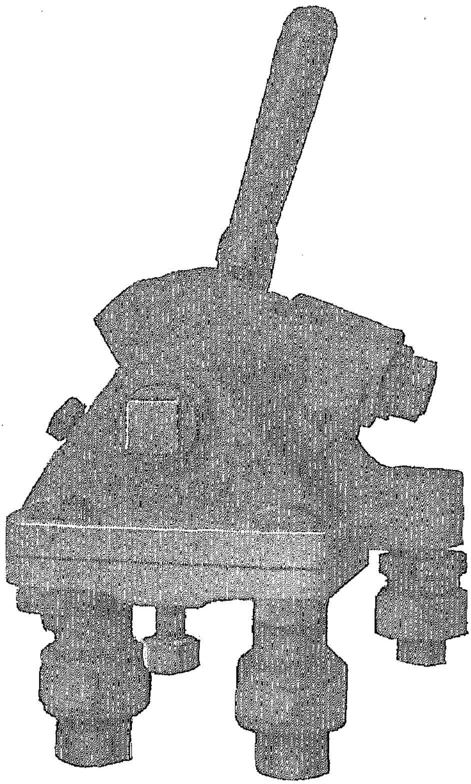

FIG. 21

independent brake valve in locomotive automatic release position to keep the locomotive brakes released when the train brakes are applied, and by moving it to service position to apply the locomotive brakes just before the train brakes are released.

The independent brake and release valve, like the previous types of straight-air brake valve, is a valuable adjunct in controlling, without the use of the train brakes, the speed of a train that is slowed down; in holding the slack bunched, under proper conditions, when releasing at slow speed and thus avoiding break-in-twos; in making close, accurate stops at water cranes and platforms without the use of a sudden application of the train brakes; in holding the train while the train brakes are released after a stop on a grade; and in promoting smooth and safe handling of trains in many other ways.

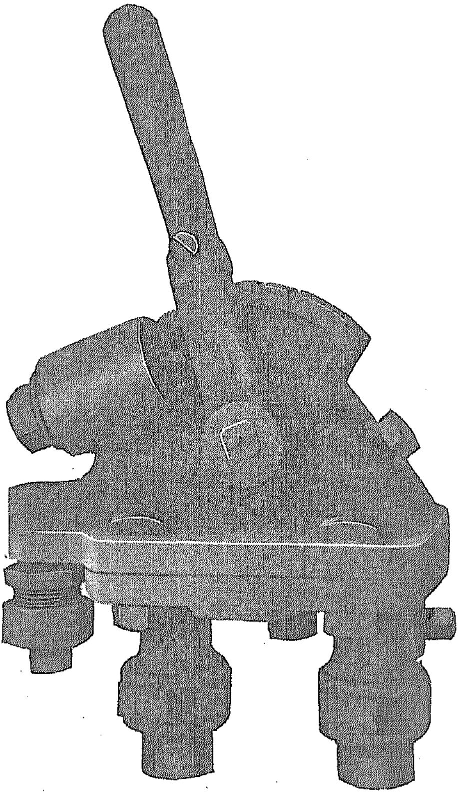

Fig. 22

27. In Fig. 21 is shown a perspective view of the front side of a C-2 independent brake and release valve, and in Fig. 22, is shown a perspective view of the back of the brake valve.

The reducing-valve pipe connection is at *R V*, Fig. 24; the straight-air pipe connection is at *S A*, and the release pipe connection is at *RP*.

The brake valve is made in two parts, the lower part, or *body*, and the upper part, or *cover*. The body and cover are held together by means of four standard nuts, two of which may be seen in the front view, and the other two in the back view. The two plugs in the cover are oil plugs, and the large plug winding between is the lever-shaft plug. The release valve R is just to the right of the handle.

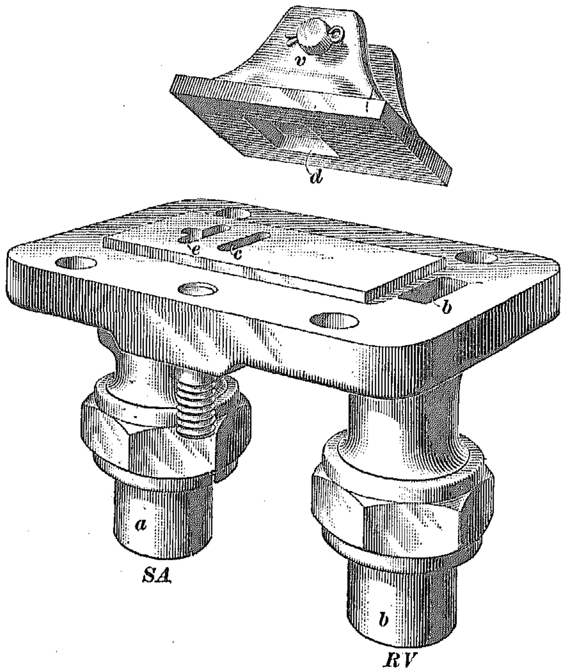

FIG. 23

28. Fig. 23 shows a view of the body of the brake valve with its valve seat exposed, showing the main-reservoir air port b, the air port e to the brake-cylinder pipe a, and the exhaust port c. It will be noticed that port e has a small extension on the side where main-reservoir air first enters, which allows a small amount of air to enter when the valve v first uncovers the port e and thus graduate the application of the brake. The slide valve v and its exhaust cavity d are shown directly above the valve seat.

29. A sectional view of the brake valve is shown in Fig. 24. It will be noted that the construction of the brake valve proper is the same as that of the style *c* straight-air brake valve used with the combined straight air and automatic brake. The only difference between the two brake valves are the addition of a fifth-position notch in the quadrant of the C-2 brake valve, and provision in the cover for the release valve and the pipe connection *R P*.

OPERATION OF THE C-2 INDEPENDENT BRAKE VALVE

30. Figs. 24 to 28, inclusive show the five positions of the brake-valve handle of the C-2 independent brake valve. The brake valve should be located close to the automatic brake valve, within easy reach of the engineer, and the handles of both brake valves should point in the same direction when in similar positions, so as to avoid confusion in an emergency. The five positions of the independent brake-valve handle come in the same relative order as on the automatic brake valve, and are as follows:

31. Release Position.—The release position, Fig. 24, is used to reduce gradually the brake-cylinder pressure or to release fully the locomotive brakes, after a straight-air application, regardless of the position of the automatic brake valve. Also, the handle of the brake valve should always be carried in release position when the independent brake is not used, because in this position the locomotive brake cylinders are connected to the atmosphere through the cavity *d* in the exhaust valve.

32. Locomotive Automatic Release Position.—The locomotive automatic release position, Fig. 25, of the independent brake valve is used to release the engine and tender brakes, but not the train brakes, after an automatic application. After an automatic application of the locomotive brakes, it is necessary to release the air from the control reservoir of the automatic control valve in order to release the locomotive brakes.

In the locomotive automatic release position, the handle strikes the stem of the release valve and forces the valve from

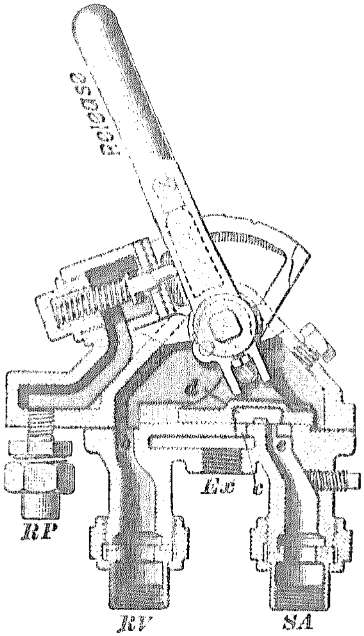

FIG. 24

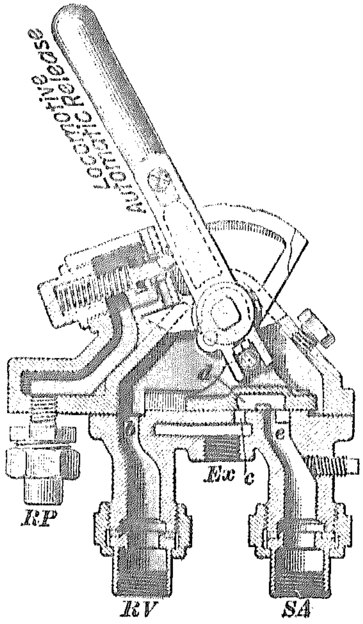

FIG. 25

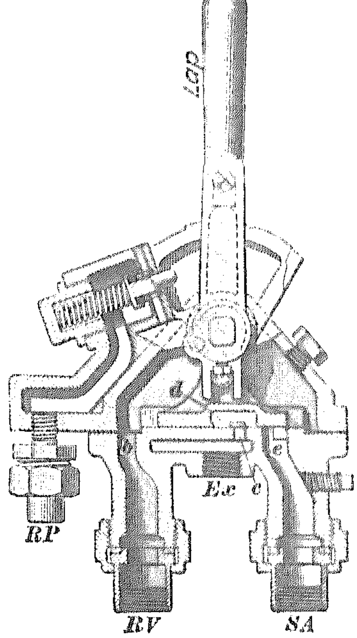

FIG. 26

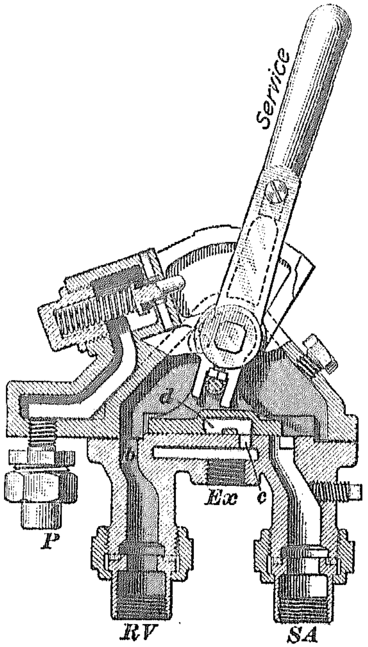

FIG. 27

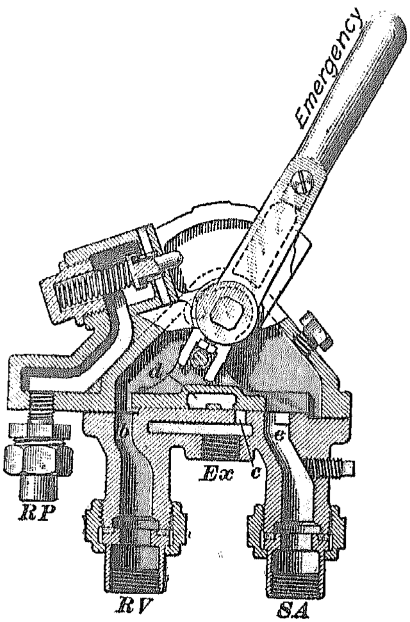

FIG. 28

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its seat, so that air from the control cylinder flows through the control-reservoir pipe to the release pipe and the connection *RP*, Fig. 25, and through the release valve to the atmosphere. Brake-cylinder pressure exhausts in the usual manner through the exhaust cavity *d* of the exhaust valve, but the pressure reduces only as the control-cylinder pressure reduces.

The release valve is opened by the brake-valve handle pressing against the stem of release valve *1* and forcing the valve from its seat. The valve must be held open against the tension of the release-valve spring, otherwise, the spring will automatically reseat the valve and return the handle to release position.

To release the locomotive brakes by means of the automatic brake valve, after an automatic application, the valve handle should be moved to running position. To release the locomotive brakes by means of the straight-air brake valve after an automatic application, the independent brake valve should be moved to locomotive automatic release position. To release the locomotive brakes after a straight air application, the independent brake valve should be moved to release position.

33. Lap Position.—The lap position, Fig. 26, is for holding the locomotive brakes applied after an application has been made. All ports are closed in this position.

34. Service Position.—Service position, Fig. 27, is used to apply the brakes gradually with a straight air application. The reducing-valve pressure flows through port *e* and the connection *S A* to the locomotive brake cylinders, applying the brakes.

35. Emergency Position.—Emergency position, Fig. 28, is for a quick application of the locomotive brakes, to their full independent brake power. The port *e* is opened wide, allowing air from the reducing-valve pipe to flow quickly into the brake cylinders and charge them to reducing-valve pipe pressure, 40 pounds.

The independent brake valve delivers air direct to, and exhausts it from, the locomotive brake cylinders. Also, the

independent brake valve, when in automatic locomotive release position, controls the passage of air from the control reservoir of the automatic control valve through the release pipe.

36. Double-Heading Precautions.—When using the C-2 valve in double-heading, the double-heading cock in the brake pipe, Fig. 1, must be closed on the following engines, and the automatic brake valve on these engines must be carried in running position, and the independent brake valves in release position, in order to give the leading engineer control of the automatic control valves on all engines. The engineer on the following engine can operate the independent brake valve to apply or release the brakes on that locomotive without interfering with the operation of the train brakes. In case the driving wheels get hot or slide while the brakes are applied, the brakes on the locomotive can be released at once by moving the independent brake valve to locomotive-automatic release position.

RELATION OF C-2 VALVE TO TYPE L VALVE

37. From the description of the operation and passage of air through the independent brake valve in the various positions of its handle, it will be seen: (1) that with the slide valve of the independent brake valve in locomotive automatic release position the locomotive brakes will be released independently of the train brakes and regardless of the position of the automatic brake valve; (2) that service position will slowly or gradually apply the locomotive brake independently of the train brakes and without regard to the position of the automatic brake valve; and (3) that emergency position will also apply the locomotive brakes independently of the train brakes and without regard to the position of the automatic brake valve, and that it will apply the brakes much quicker than the service position.

38. The service and release positions of the independent brake valve operate to apply and release the locomotive brake independently of the automatic brake valve.

The independent brake valve, except when held in locomotive automatic release position, will not interfere with the automatic application of the locomotive brakes.

If the independent brake valve is held in emergency position, air will flow to the brake cylinders, and if the single-pressure controller is adjusted too high or if it leaks badly, the pressure in the locomotive brake cylinders will be raised above the standard. If it is not held in locomotive automatic release position, the release spring will return it to release position.

AUTOMATIC CONTROL VALVE

DESCRIPTION

39. The **L T automatic control valve** with its double-chamber reservoir is the most essential part of the L T equip-

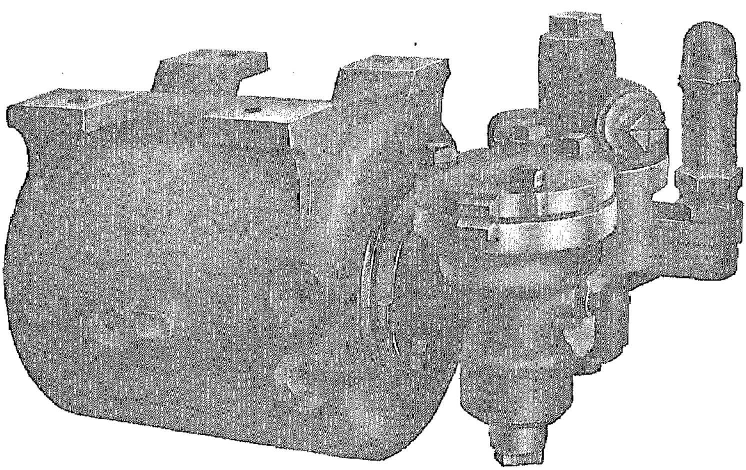

Fig. 29

ment. This valve operates the locomotive brakes only. It takes the place and performs all the functions of the triple valves, auxiliary reservoir, and high-speed reducing valves

used with the former types of locomotive brake. It is directly connected to the double-chamber reservoir, and all the pipe

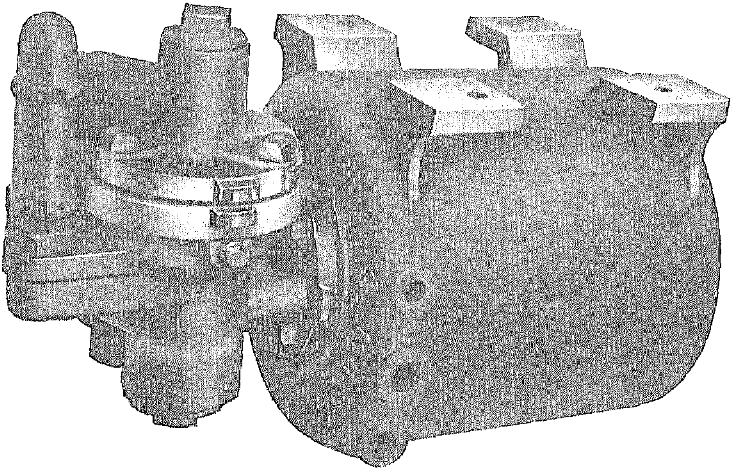

FIG. 30

connections, of which there are five and sometimes six are made to the reservoir.

40. Three views of the L T automatic control valve and its

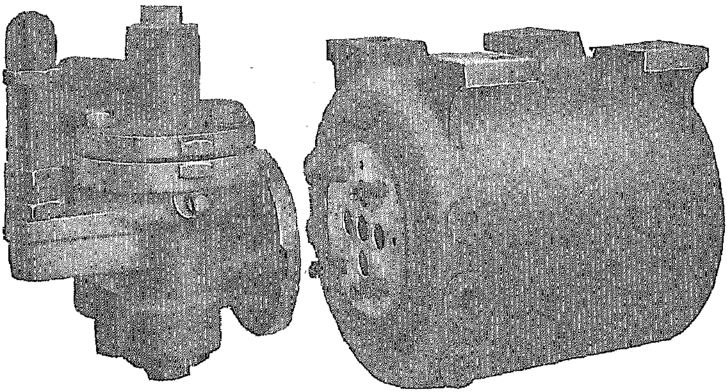

FIG. 31

double-chamber reservoir are shown in Figs. 29, 30, and 31. Figs. 29 and 30 show the control valve connected to its double-

chamber reservoir, and Fig. 31 shows this valve separated from its reservoir. Fig. 29 is a view of the control-cylinder-cap side of the valve, showing three of the pipe connections to the reservoir, and Fig. 30 is a view of the triple-cylinder-cap side, showing the other three pipe connections to the reservoir. From these views it will be seen that all pipe connections are made to the double-chamber reservoir, and that the automatic-control valve can be separated from its double-chamber reservoir without disturbing any of the pipe connections.

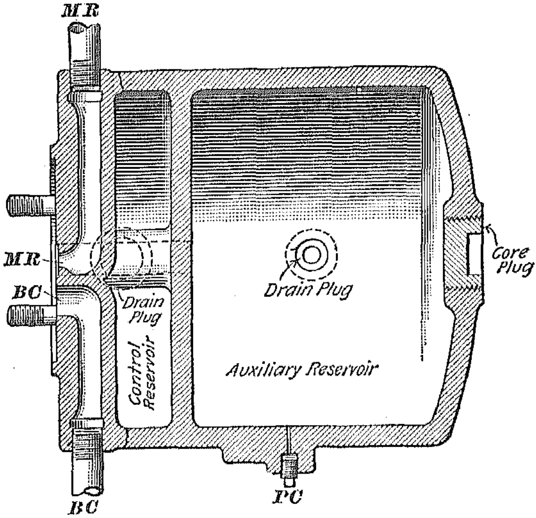

FIG. 32

41. Fig. 32 is a side view of the double-chamber reservoir sectioned in such a manner as to show the partition between the auxiliary-reservoir chamber and the control-reservoir, as well as the relative sizes of these chambers. This view also shows the ports *M R*, *B C*, and the core and drain plugs. The auxiliary-reservoir chamber represents an auxiliary reservoir, and the control-reservoir chamber, combined with the control cylinder of the automatic control valve, represents a brake cylinder. These chambers have the relative proportions to each other of an auxiliary reservoir and its proper brake cylinder with 8 inches of piston travel; thus, when the auxiliary-reservoir

chamber is charged with air at 70 pounds per square inch, the same as that in the brake pipe and auxiliaries on the train, the volume of air therein will equalize in both chambers at 50 pounds, and in that proportion at every other auxiliary-reservoir pressure. The volume of the control cylinder of the automatic-control valve is included in the volume of the control reservoir at all times. The volume of the slide-valve chamber in the automatic control valve is included in the volume

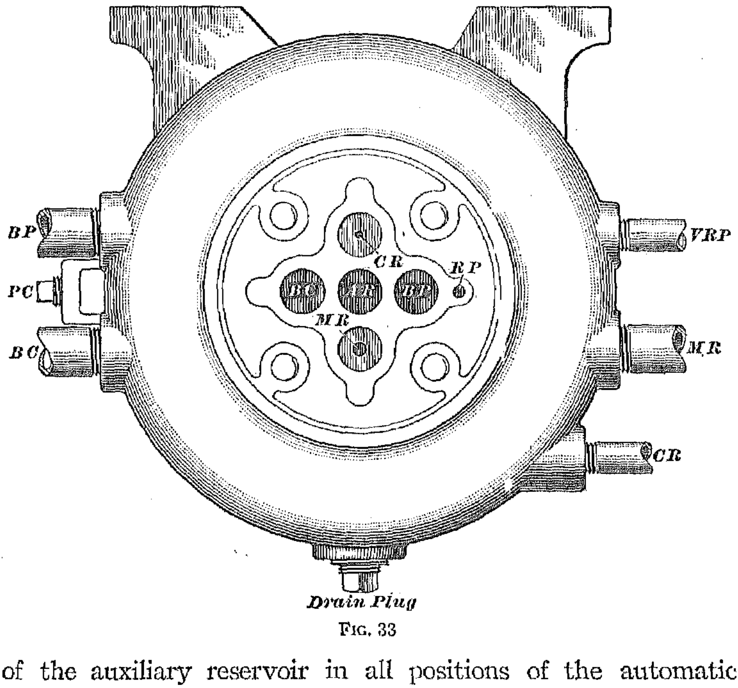

FIG. 33

of the auxiliary reservoir in all positions of the automatic control valve.

42. In Fig. 33 is shown a plan view of the automatic control-valve face of the double-chamber reservoir. This view shows the six pipe connections to the double-chamber reservoir, as well as the ports in the automatic control-valve face of the reservoir.

In Fig. 34 is shown a photographic reproduction of the control valve removed from its double reservoir.

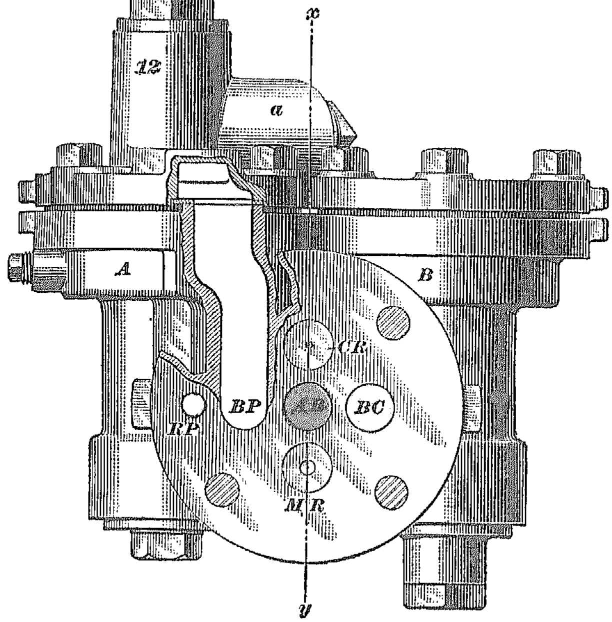

FIG. 35

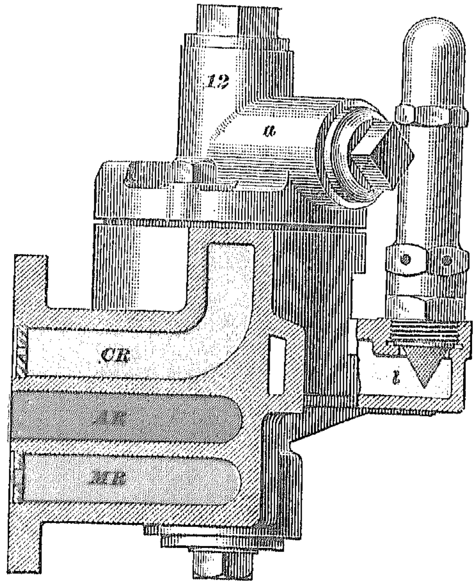

FIG. 36

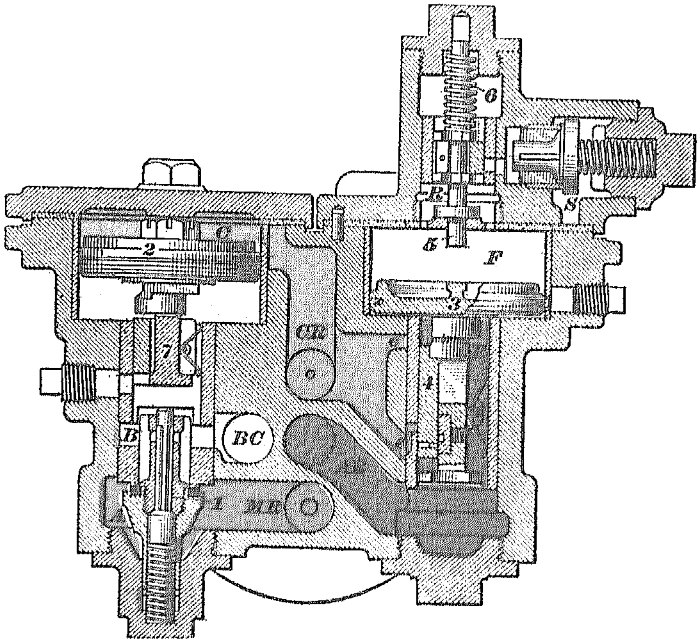

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FIG. 37

A plan view of the reservoir face of the automatic control valve, illustrating the relative positions of the several ports, is shown in Fig. 35. In the illustration, *A* is the control-valve side, and *B* the slide-valve side; *a* is the quick-action part of triple-cylinder quick-action cap *12*. Also, this figure indicates the walls of the automatic control valve broken away so as to

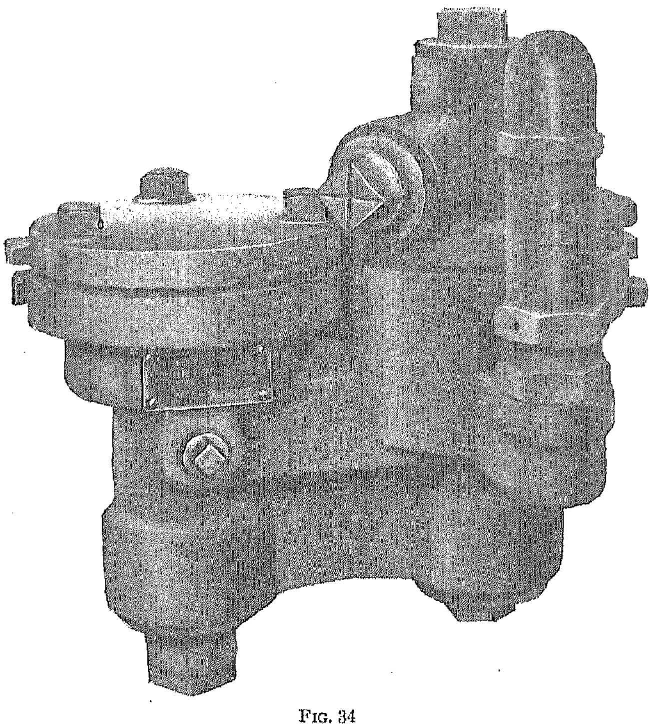

FIG. 34

show the path of the port *BP*. The port leads to the triple cylinder-cap end, as shown.

43. In Fig. 36 is shown a sectional view of the automatic control valve taken on the line *x y*, Fig. 35, and showing the ports *A R*, *C R*, and *M R*. It will be noted that there is a choke in port *M R*, and a smaller choke in *C R*.

Fig. 37 shows a sectional view of the automatic control valve taken on the center line of the cap *12*, Fig. 36, the part to the

right of the center line being removed. Fig. 37, shows that port *M R* leads to chamber *A* below the control valve check-

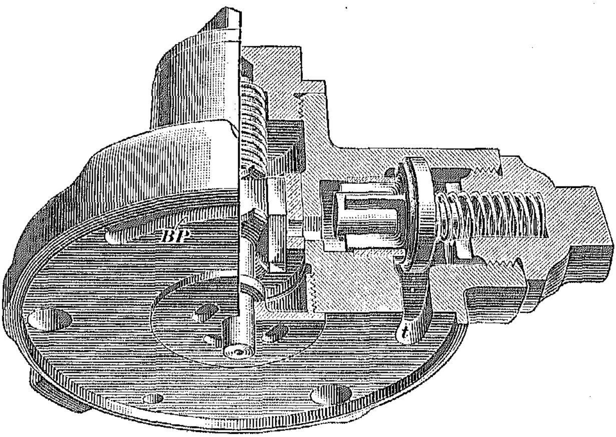

FIG. 38

valve *1*; that port *A R* leads into chamber *E* surrounding the slide valve *4*; that port *C R* divides one leg leading to chamber *C*

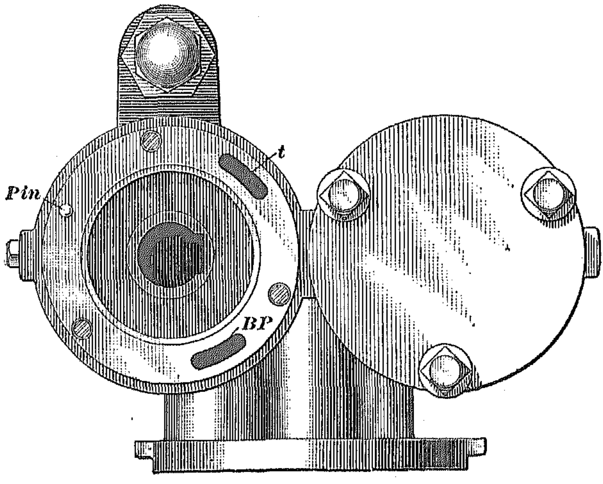

FIG. 39

between the control piston *2* and the control cylinder cap and the other leg leading to ports *e* in the slide valve-seat (see

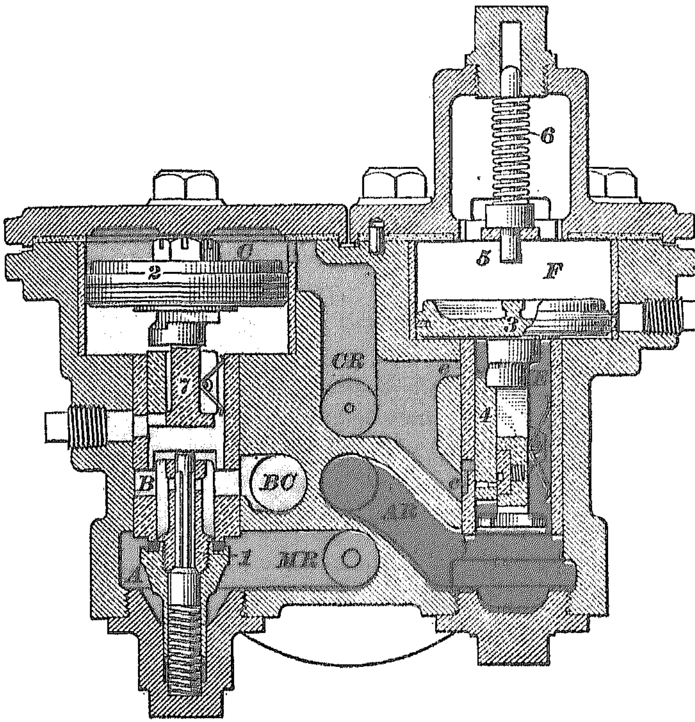

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FIG. 41

Fig. 40); and that port *B C*, Fig. 35, leads to chamber *B* between the exhaust valve and the control valve-check valve.

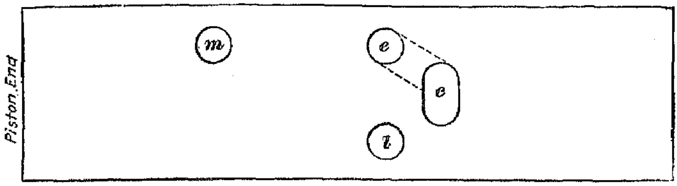


FIG. 40

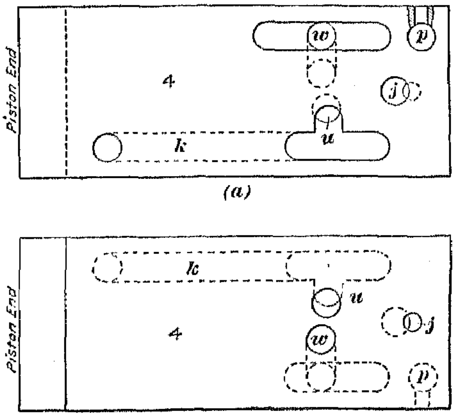
Fig. 38 illustrates the triple cylinder cap sectioned so as to show the port *B P* and the chamber *O*, above the check quick-action valve, and port *t* leading into the chamber surrounding the quick-action check valve.

Fig. 39 is a plan view of the triple cylinder with the triple-cylinder cap removed.

Fig. 40, which is a plan view of the slide-valve seat.

Fig. 41 is the same sectional view as that shown in Fig. 37, except that the quick-action triple cylinder cap is replaced with a plain cap.

44. The plan view of the slide-valve seat, Fig. 40, illustrates the four ports in the seat. Both ports *e* connect with the passage *C R*, Fig. 37, and lead to the control reservoir and cylinders. Port *l* leads to the safety valve, Fig. 36, and port *m* to the automatic control-valve retain pipe, Fig. 3.



(a)

(b)

FIG. 42

45. The slide valve is illustrated in Figs 42 to 46, inclusive. Fig. 42 (*a*) is a view of the face of the valve, and (*b*), a view of the top of the valve, showing the graduating-valve seat.

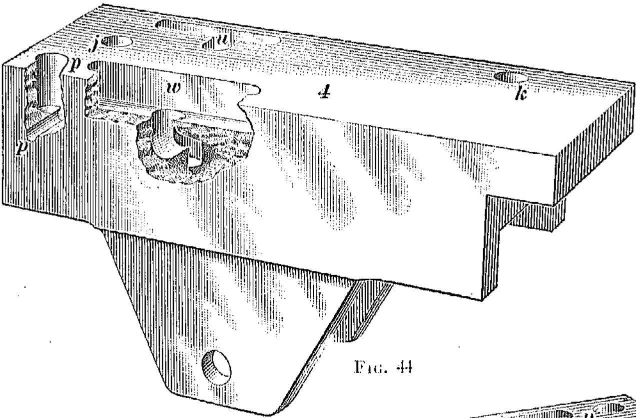


Fig. 44

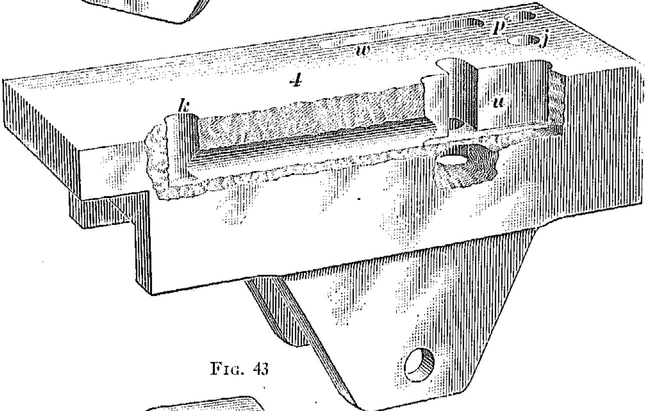


Fig. 43

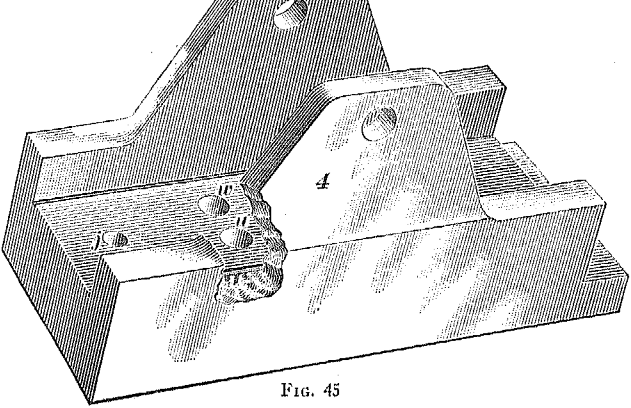


Fig. 45

Fig. 43 is a perspective view of the slide valve, with part of it broken away so as to show how port *k* leads into the cavity *n* and how port *u* leads from the cavity to the seat of the graduating valve, Fig. 45.

The perspective view of the slide valve, Fig. 44, is broken away to show how port *p* leads to the side of the valve, and how port *w* leads from the cavity *v* to the seat of the graduating valve, Fig. 45. Port *j*, Fig. 44, passes straight through from the face of the valve to the seat of the graduating valve.

46. In Fig. 46 (*a*) is shown the slide-valve spring *18*; in (*b*), the triple-valve piston *3*, with the slide valve *4*, its spring *18*, the graduating valve *10*, and its spring *19* removed from the piston, and the pin *j* that holds the graduating valve and its spring in position and prevents the valve from being put in wrong end to; in (*c*), the graduating-valve spring *19*; in (*d*), a view of the face of the graduating valve *10*, showing its cavity *v*; and in (*e*), a view of the triple valve piston *3*, with the slide valve in place and a part of the piston broken away, so as to show the packing ring and the groove in which the ring fits.

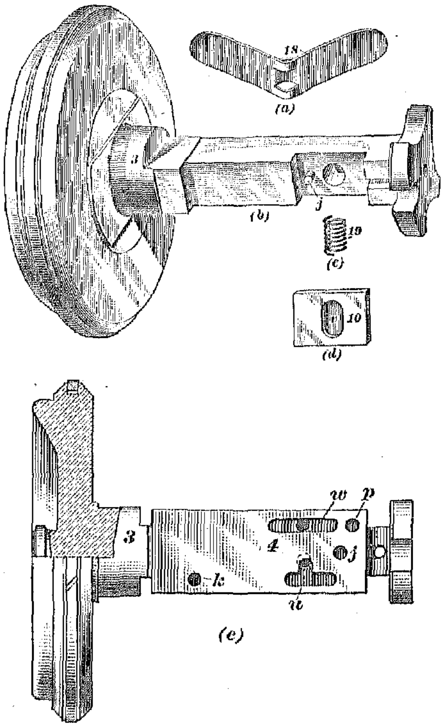


FIG. 46

47. A view of the exhaust-valve seat is shown in Fig. 47. The port *n* is the exhaust port of the automatic control valve.

A perspective view of the control piston, with the exhaust valve in position, is shown in Fig. 48. There are neither ports nor cavities in the face of the exhaust valve. The exhaust valve fits in between two shoulders on the control-piston stem, and is operated by the control piston. The piston is moved back and forth by creating a difference of pressure on its two faces.

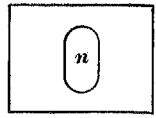


FIG. 47

48. An enlarged view of the *control valve 1* is shown in Fig. 49. It consists of the check-valve *a*, called the *admission valve*, and the inner check-valve *b*, called the *preliminary admission valve*. The part *c* is the preliminary admission valve guide, while *8* is the check-valve spring, and *9* is the main-reservoir chamber cap. The spring holds both check-valves to their seats by forcing the inner check-valve against the check-valve guide, which is connected to the check-valve.

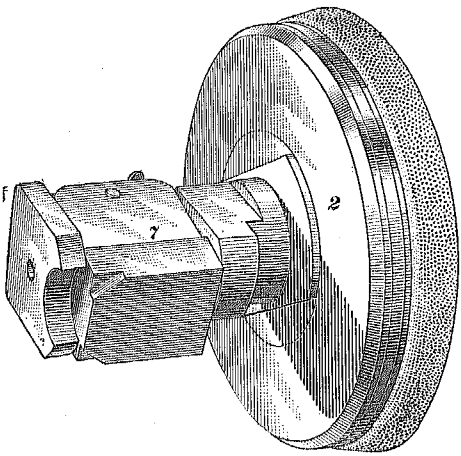


FIG. 48

The operation of the control valve is as follows: As the control piston *2* moves down, the stem first strikes against the preliminary admission valve, forcing it from its seat against the tension of the check-valve spring *8* and the air pressure in chamber *o*. Since the area of the preliminary admission valve is considerably smaller than that of the admission valve, the valve is opened by a very light difference of pressure on the control piston *2*.

The admission valve is extended so as to form a guide in the cap nut *9*, thus forming chamber *o*. When the preliminary admission valve is forced from its seat, the air in chamber *o* passes by the valve into the brake cylinder faster than it can

flow past the close-fitting extension of the admission valve. This reduces the pressure on the part of the valve that tends to hold the valve to its seat, and has the effect of partly balancing the valve so that it can be opened against main-reservoir pressure by a small difference in pressure on the faces of the control piston *2*.

49. Parts of Automatic Control Valve.—Referring to Figs. 36, 37, 41, 46, 48, and 50, the numbers and names of the various parts of the automatic control valve are as follows: *1*, control valve; *2*, control piston; *3*, triple-valve piston; *4*, slide

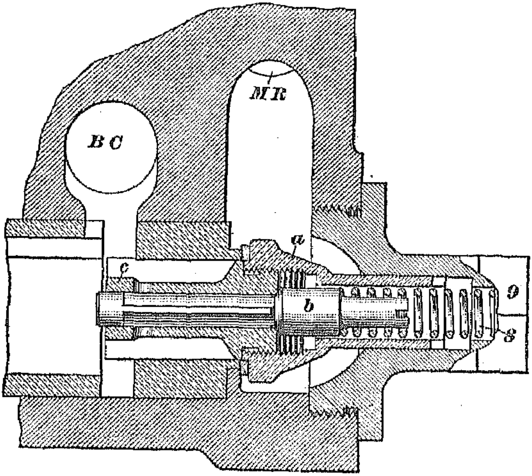


FIG. 49

valve; *5*, graduating stem; *6*, graduating spring; *7*, exhaust valve; *8*, check-valve spring; *9*, main-reservoir chamber caps; *10* graduating valve; *11*, triple cylinder gasket; *12*, triple cylinder cap; *13*, control-cylinder cap; *14*, safety valve; *18*, slide-valve spring; *19*, graduating valve spring.

50. Pipe Connections and Air Passages in Automatic Control Valve and Double-Chamber Reservoir. There are five connections to the double-chamber reservoir, Figs. 29, 30, and 33 that are numbered and lettered as follows: *M R* for main-reservoir pipe connection; *B P* for brake-pipe

connection; *B C* for brake-cylinder pipe connection; *C R* for control-cylinder pipe connection; and *3* for retain-pipe connection. The course of the passages within the automatic control valve leading from these connections can best be learned by tracing each passage through Figs. 35 to 41, inclusive, and the diagrammatic view, Fig. 50. A sixth pipe connection, shown at *x*, Fig. 29, is the pipe connection for the pipe *P C*, Fig. 3.

DUTY OF PARTS OF AUTOMATIC CONTROL VALVE

51. The duty of the triple-valve piston *3* is to control the movement of the slide valve *4* and the graduating valve *10*, as well as to open and close the feed groove *g*. It is caused to move by creating a difference of pressure on its two faces, the greater pressure moving it toward the lesser pressure. The slide valve *4* opens and closes communication between the auxiliary reservoir, the control cylinder, and the control reservoir, and between the control cylinder, the control reservoir, and the control-valve exhaust. The slide valve also opens the communication between the auxiliary reservoir and the safety valve in emergency position. The slide valve is made shorter than the distance between the shoulders on the triple-piston stem, so that, when it is in service position, the piston can move the graduating valve far enough to open and close port *j* without moving the slide valve. The graduating valve *10* opens and closes port *j* in the slide valve *4*, and thus graudates the flow of air from the auxiliary reservoir chamber into the control reservoir and cylinder when a graduated-service application is made with the automatic brake valve. The graduating valve also opens communication between the control reservoir and cylinder and the safety valve through ports in the slide valve and slide-valve seat when in service position, and closes this communication when in service-lap position.

52. The control piston *2* controls the movement of the control valve *1* and the exhaust valve *7*. It is caused to move by increasing or decreasing the pressure in the control cylinder above or below that in the exhaust-valve chamber. The

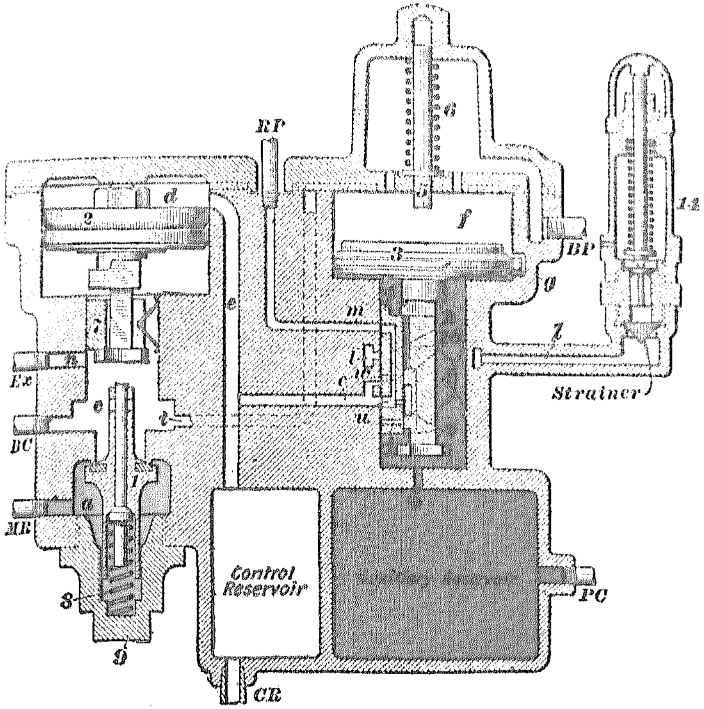


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Fig. 50

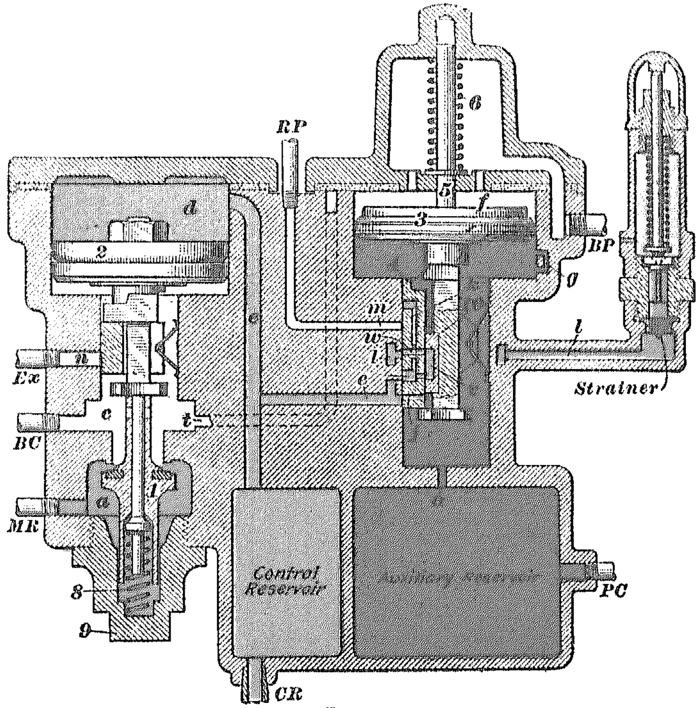

Fig. 51

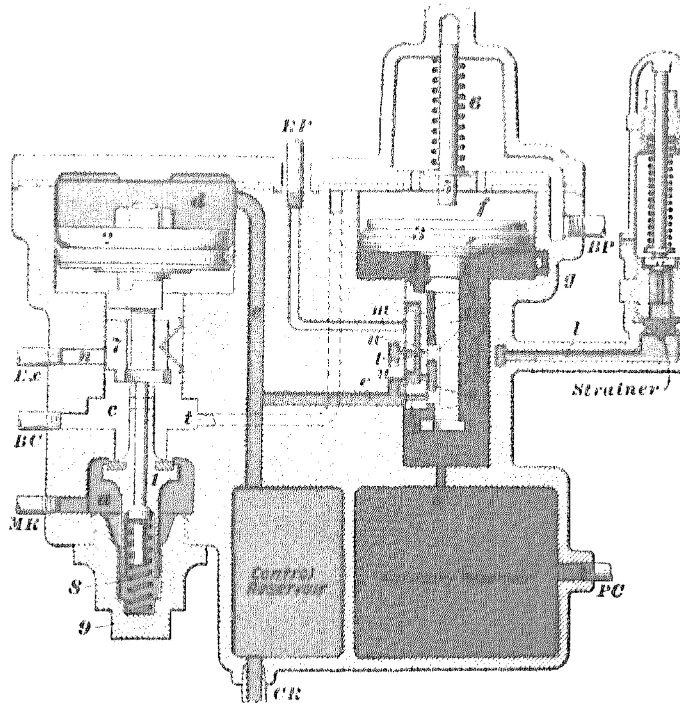

Fig. 52

control valve controls or graduates the flow of main-reservoir air from the main-reservoir chamber *a* to the exhaust-valve chamber *c* and the locomotive brake cylinders when the brakes are being applied by the automatic brake valve. The exhaust valve *7* opens and closes the brake-cylinder exhaust port *n*. It is made shorter than the distance between the shoulders on the control-piston stem, so that when the exhaust valve is in lap position, piston *2* can open and close the control valve *1* without disturbing the exhaust valve.

The check-valve spring *8* acts as a cushion for piston *20* when it is moved to application position. It also assists the pressure in the exhaust-valve chamber in moving the control piston *2* back to lap position when the pressure in this chamber and that in the control cylinder are nearly equalized. As the piston *2* starts from lap to application position the check-valve spring *8* is compressed, and when the pressure in the exhaust-valve chamber *c* becomes a trifle greater than that in the control cylinder *d*, spring *8* asists in moving piston *2* back to lap position.

The triple-valve-piston graduating spring *6* performs the same functions as the graduating spring in a triple valve. It assists in preventing the triple-valve piston from moving past service position during a service application on a short train, and also aids in starting the piston from emergency position toward release position.

The control piston *2* is provided with a packing leather and a packing-leather expander, as well as with a packing ring. These prevent air from leaking from the control cylinder into the exhaust-valve chamber during an application of the brakes.

53. There are two pistons in the automatic control valve. The one on the left, Fig. 50, or *control*, piston, controls the movement of the control valve that controls the brake-cylinder air supply during an application of the locomotive brakes and the exhaust valve that exhausts brake-cylinder air to the atmosphere during a release of the brakes. The piston on the right, Fig. 50, or *triple-valve* piston, controls the movement of the slide and graduating valves. The triple-valve piston, slide valve, and graduating valve operate the same as the triple

piston, slide valve, and graduating valve of a triple valve. They control the flow of air from the auxiliary reservoir into the control cylinder and the control reservoir during an automatic application of the brakes, and from the control cylinder and the control reservoir to the automatic control-valve exhaust when the brake is to be released by the automatic brake valve. The triple-valve piston is operated by variations in brake-pipe pressure, and the control piston is operated by changes of pressure in the control cylinder or in the exhaust-valve chamber. With the ordinary automatic brake, the pressure in the brake cylinder depends on the amount of air the triple valve passes from the auxiliary reservoir into the brake cylinder; but with the L T equipment, the supply of air for the locomotive brake cylinders in automatic operations comes from the main reservoir, and the pressure in the brake cylinders is determined by the pressure in the control cylinder of the automatic control valve. With an automatic application, the pressure in the control reservoir and cylinder depends on how much air the triple-valve piston and its slide and graduating valves pass from the auxiliary reservoir into the control cylinder.

54. In another method of varying the pressure in the brake cylinders to apply and release the locomotive brakes, no movement of the automatic control valve is required. This operation is performed by means of the independent brake valve. This brake valve can be operated to pass air from the reducing-valve pipe direct into the brake cylinder or to discharge air from the brake cylinder to the atmosphere. This applies or releases the locomotive brakes independent of the automatic brake valve.

AUTOMATIC OPERATION OF THE AUTOMATIC CONTROL VALVE

55. Figs. 50 to 56, inclusive, show conventional views of the automatic control valve and its double-chamber reservoir. As the parts, ports, and cavities in the automatic control valve are located so that they cannot be shown in a true sectional view, these conventional views have been prepared to help in the study of the operation of the valve. The views show the

auxiliary reservoir and the control reservoir of the double-chamber reservoir as a part of the automatic control valve and of a different shape from the original, being smaller in proportion to the size of the valve, but with the same relative proportion to each other. However, it must be borne in mind that these conventional views are given in order to simplify the tracing of the air through the various ports and to help explain the operation of the valve, rather than to show its actual construction and the proper location of the various ports.

56. Automatic Charging Position.—When the automatic control valve is charging, air from the main reservoir enters at the connection *M R*, Fig. 50, and passes into the control valve chamber *a*. This supply of main-reservoir air is always present around the control valve *1*, unless the main-reservoir cut-out cock or the automatic control-valve cut-out cock is closed.

In charging the train, when air is first admitted to the brake pipe *P*, it enters the automatic control valve at the brake-pipe connection *B P* and passes into chamber *f*. If the triple-valve piston is not already in release position, the air entering chamber *f* will force it to release position; then all parts will assume the positions shown in Fig. 50. The feed groove *g* is opened by the triple piston *3*, and air from chamber *f* will pass through groove *g* into the slide-valve chamber, thence through port *o* to the auxiliary reservoir, until full brake-pipe pressure is obtained in this reservoir. The feed groove *g* is made of such a size that it will charge the auxiliary reservoir at the same rate as the feed groove in a triple valve will charge its auxiliary reservoir.

57. Automatic Release Position.—The automatic release position of the automatic control valve is shown in Fig. 50. To release the locomotive brakes through the automatic brake valve, it is necessary that the automatic brake valve be in running position. When the automatic brake valve is placed in release position, air from the main reservoir passing into the brake pipe increases the brake-pipe pressure, which

causes the triple valves on the cars to move to release position and release the train brakes. At the same time, the increase of brake-pipe pressure also increases the pressure in chamber *f* of the automatic control valve above that in the slide-valve chamber, which forces the triple-valve piston *3* toward release position, carrying with it the slide valve *4* and the graduating valve *10*. When in this position, the triple-valve piston *3* opens the feed groove *g*, which allows air from chamber *f* to flow through groove *g* past piston *3* to the slide-valve chamber, and out through passage *o* into the auxiliary reservoir, until the pressure equalizes on both sides of the piston *3*. The slot *u* and the passage and port in the slide valve connects port *e* with the exhaust port *m* that leads to the retain pipe, but as the automatic brake valve is in release position, its rotary valve closes the opening from the retain pipe to the atmosphere and prevents the automatic control valve from releasing the locomotive brakes. In order to connect the retain pipe with the atmosphere and thus release the locomotive brakes with the automatic brake valve, the automatic brake valve must be moved to running position. This allows the air from the control cylinder and reservoir to escape to the atmosphere through ports *e*, *u*, and *k*, and on into the retain pipe, thence through the automatic brake valve and out to the atmosphere. As the air in the control cylinder and reservoir reduces, the greater pressure in the exhaust-valve chamber moves piston *2* forwards, carrying with it the exhaust valve *7*. This movement of the exhaust valve connects the brake cylinders with the atmosphere and allows the brake-cylinder pressure to escape through port *n*, thus releasing the locomotive brakes.

To graduate the release of the locomotive brakes, through the automatic brake valve, the handle of the automatic brake valve should be left in running position just long enough to reduce the control cylinder pressure the desired amount, after which it should be moved to lap or holding position. As the pressure in the control cylinder reduces, the greater pressure in the exhaust-valve chamber will move piston *2* and valve *7* forwards and the exhaust valve will allow brake-cylinder air to escape through port *n* until the pressure in the exhaust-valve

chamber is slightly less than that remaining in the control cylinder, when the greater pressure in the control cylinder will move piston *2* and exhaust valve *7* to the right and stop the flow of brake-cylinder air to the atmosphere.

58. Automatic Service Position.—Fig. 51 shows the automatic control valve in automatic service position. When making an automatic service application of the brakes, brake-pipe pressure is reduced. This reduces the pressure in chamber *f* of the automatic control valve, and since the feed groove *g* is very small, the pressure in chamber *f* can reduce faster than the auxiliary reservoir air can pass back through the feed groove *g*. The greater pressure in the slide-valve chamber will then move the triple-valve piston *3* forwards. This movement cuts off communication between the slide-valve chamber and chamber *f*, by closing the feed groove *g*. The graduating valve *10*, which fits snugly between the shoulders on the piston stem, is also moved on the back of the slide valve so as to uncover the upper ends of ports *u* and *w* in the slide valve, and cavity *v* in the graduating valve *10* connects the ports *u* and *w*. By this time, the shoulder on the end of the piston stem has engaged the slide valve, and a further movement of piston *3* carries the slide valve with it and all these parts assume service position, as shown in Fig. 51. When the valves are in this position, port *u* of the slide valve is moved so that ports *u* and *e* connect, but port *k* no longer connects with the exhaust port *m*. Port *j* in the slide valve connects with port *e* in the valve seat, thus opening communication between the auxiliary reservoir and the control cylinder and the control reservoir. Also, port *w* is moved over port *l* and the cavity *v* in the graduating valve connects port *l* with port *w*, thus opening communication between the control cylinder and control reservoir and the safety valve. The triple-valve piston stands against the graduating stem *s*, but does not compress the graduating spring, because of its resistance and the fact that the slightly greater pressure in the slide-valve chamber is gradually reduced by the air passing through port *j*. If the pressure in the slide-valve chamber should be greatly in excess of the pressure in chamber *f*, the graduating

spring would be compressed and the parts would assume emergency position.

Air passing from the auxiliary reservoir into the control cylinder and reservoir builds up a pressure on the control-cylinder side of the control piston *2*, which forces this piston backwards. This movement of piston *2* also moves the exhaust valve *7*, as shown in Fig. 51. The check-valve spring *8* strikes the main-reservoir chamber *9*, and the spring *8* is compressed. When the control piston moves the exhaust valve it first closes the exhaust port *n*, and thus cuts off the brake cylinders from the atmosphere. The control-piston stem then unseats the control valve *1* and thus connects chamber *a* with chamber *c*, allowing main-reservoir air to flow into the brake cylinders.

59. If the reduction in the brake-pipe pressure is not great enough to equalize the pressures in the control cylinder, the control reservoir, and the auxiliary-reservoir, air from the slide-valve chamber will continue to flow through ports *j* and *e* until the pressure on the auxiliary-reservoir side of the triple piston *3* is a trifle less than that remaining in the brake pipe. The greater pressure in chamber *f* will then move the triple-valve piston *3* and graduating valve *10* until the graduating valve closes the upper end of port *j* as shown in Fig. 52, stopping the flow of air from the auxiliary reservoir to the control reservoir and the control cylinder, thus preventing any further increase in control-cylinder pressure. The graduating valve has also closed the top end of port *w* and cut off communication between the control cylinder and the safety valve, so that if the safety valve leaks, the leak cannot reduce the pressure in the control cylinder.

Main-reservoir air *a* will continue to flow through the control valve, the exhaust-valve chamber, and to the brake cylinders until the pressure in the exhaust-valve chamber slightly exceeds that in the control cylinder, when the greater pressure in the exhaust-valve chamber, assisted by the check-valve spring *8* will move piston *2* far enough to allow the control valve *1* to close and stop the flow of main-reservoir air into the exhaust-valve chamber. This position, Fig. 52, is called *automatic service lap position.*

60. If another reduction in brake-pipe pressure is now made, the greater pressure in the slide-valve chamber will again move the triple-valve piston *3* until it strikes the graduating stem. Since the slide valve is already in service position, this movement of piston *3* moves only the graduating valve *10*, which opens the top end of port *j* and connects the top end of ports *u* and *w* through cavity *v*. Air from the auxiliary reservoir will again pass through ports *j* and *e*, thereby increasing the pressure on the control-cylinder side of the control piston *2* above that in the exhaust-valve chamber, which will move piston *2* so as to open the control valve. Main-reservoir air will then flow from chamber *a* through control valve *1* to the exhaust-valve chamber, thence to the locomotive and tender-brake cylinders. When the pressure in the slide-valve chamber becomes a trifle less than that in chamber *f*, triple-valve piston *3* will again be forced backwards by the greater pressure in chamber *f* and the graduating valve *10* will close the top end of ports *j* and *w*. When the pressure in the exhaust-valve chamber becomes slightly higher than that in the control cylinder, the greater pressure and the force of the check-valve spring *8* will move the control piston *2* forwards and close the control valve *1*, thereby stopping the flow of main-reservoir air into the locomotive brake cylinders.

Each reduction applies the locomotive brakes harder as long as the pressure in the auxiliary reservoir exceeds that in the control cylinder and reservoir, but when these have equalized, the brake is fully set and a further reduction would only be a waste of brake-pipe air. When a brake-pipe pressure of 70 pounds is carried, a 20-pound gradual brake-pipe reduction will cause the pressures in the control reservoir and the control cylinder, and the auxiliary reservoir to equalize at a pressure of 50 pounds, resulting in a 50-pound brake-cylinder pressure, the same as a car brake that has standard piston travel. When the slide valve and graduating valve are in service position, the control cylinder is in communication with the safety valve through ports *e* and *u*, cavity *v*, port *w*, and port *l*. As the safety valve is set at 50 pounds, it will limit the pressure in the control cylinder and reservoir to that amount.

61. Automatic Emergency Position.—When a sudden and heavy reduction in brake-pipe pressure is made, it causes the automatic control valve to operate quick-action, and the movable parts will assume the position shown in Fig. 53. This sudden and heavy reduction may be made by placing the automatic brake valve in emergency position, by the train parting, by a burst hose, or by opening a conductor's valve or angle cock. The pressure in chamber *f* of the automatic control valve being suddenly reduced, the greater pressure in the slide-valve chamber quickly moves the triple-valve piston *3* forwards with sufficient force to compress the graduating spring *6*, thus allowing the triple-valve piston to move its full stroke and rest against the gasket *11*. This movement carries the slide valve *4* with it to emergency position, port *e* in the slide-valve seat is uncovered, and air from the auxiliary reservoir passes through port *e* to the control cylinder. The operation of the control piston *2*, the control valve *1*, and the exhaust valve *7* in emergency applications is the same as in service applications, except that they are moved to application position much quicker, and control valve *1* would naturally be opened wider and more quickly than in service applications.

62. When the pressure in the exhaust-valve chamber becomes equal to that in the control cylinder, the control piston will be moved to the position shown in Fig. 54, the same as in service applications. When the auxiliary reservoir is charged to 70 pounds, an emergency application will equalize the pressures in the auxiliary-reservoir chamber, the control cylinder, and the control reservoir at about 50 pounds, but when the automatic brake valve is in emergency position, air from the main reservoir will pass through a small port in the rotary valve of the automatic brake valve and into the control-cylinder pipe, thence to the control cylinder of the automatic-control valve, which raises the pressure therein above 50 pounds. The amount of pressure that will be allowed to accumulate in the control cylinder will be determined by the adjustment of the safety valve, to which it is connected through port *l* in the valve seat, and port *p* in the valve, Figs. 40 and 42.

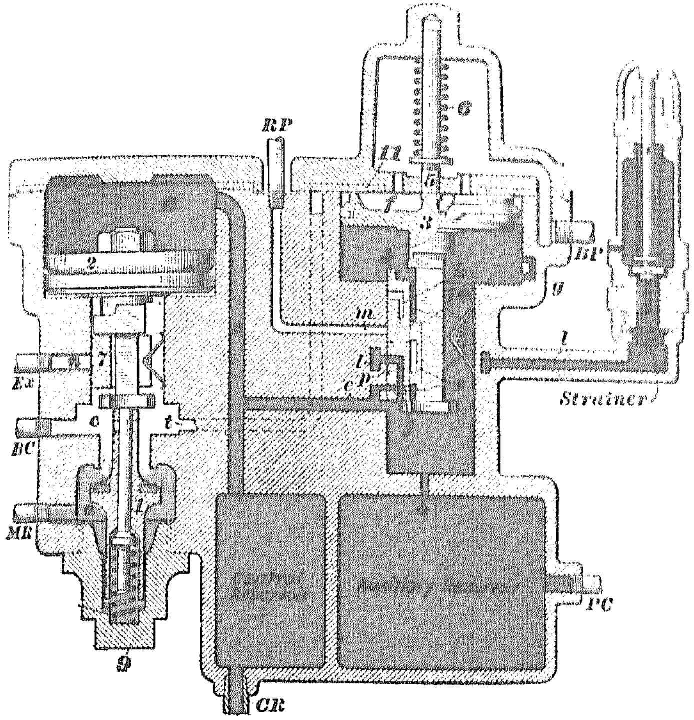

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Fig. 53

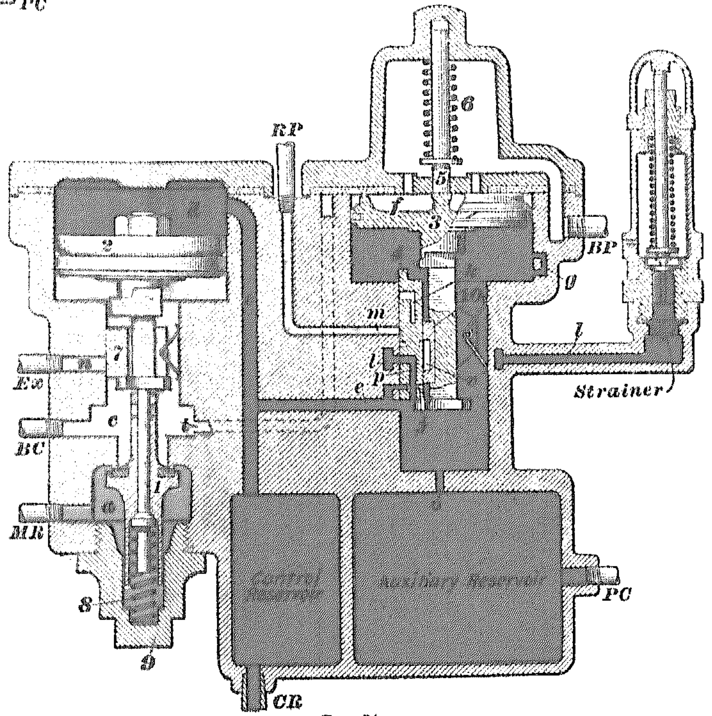

Fig. 54

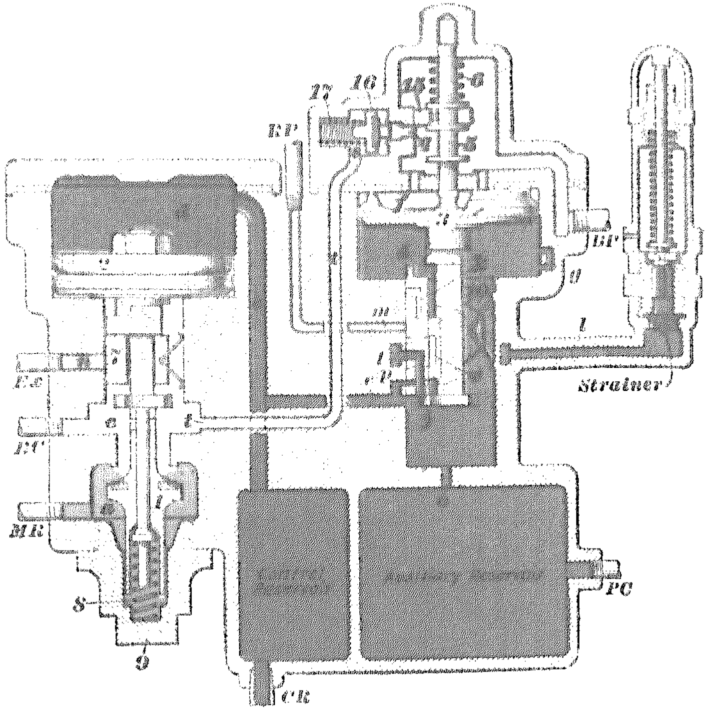

Fig. 55

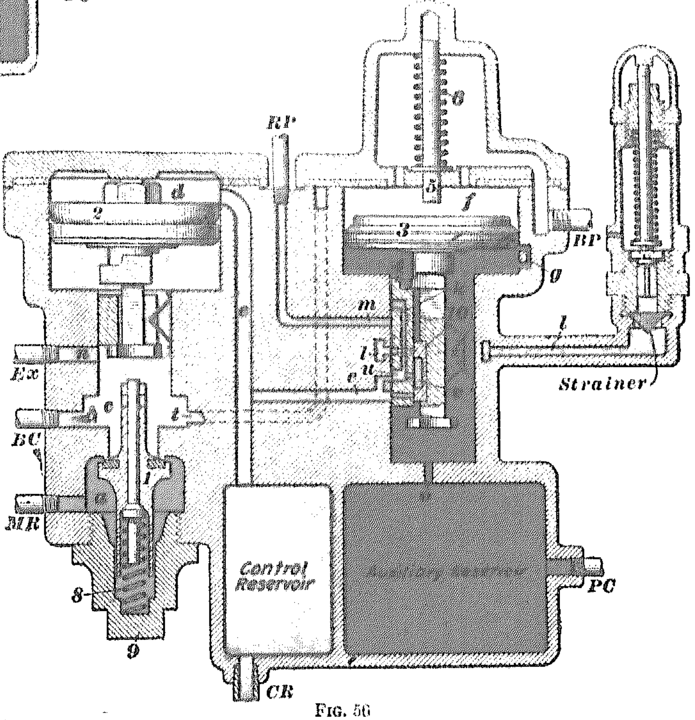

Fig. 56

When the triple-valve piston *3* and valves *4* and *10* are in emergency position, and the control piston *2* and exhaust valve *7* have moved to service position and then lapped the exhaust port in the exhaust-valve seat, the automatic-control valve is said to be in *automatic emergency lap position*, Fig. 54.

63. If the emergency application is caused by a burst hose, by the opening of a conductor's valve, or by the train parting, the automatic brake valve must be lapped to save main-reservoir air. Under these conditions the automatic-control valve will operate in the same manner as previously explained, but, since the automatic brake valve is not in emergency position, no main-reservoir air will pass to the automatic-control valve through the control-cylinder pipe; therefore, the brake-cylinder pressure will not be so high as if the application were made by the automatic brake valve. After a full-service application, if a greater brake-cylinder pressure is necessary, main-reservoir pressure may be conveyed to the control cylinder of the automatic-control valve by placing the automatic brake valve in emergency position.

64. Emergency Position With Quick-Action Cylinder Cap.—The triple valve part of the automatic control valve is furnished with a plain cylinder cap. This is standard practice. However, when specially ordered, a quick-action cylinder cap is furnished, as in Fig. 55. When thus equipped, the triple valve part of the automatic control valve corresponds to a quick-action triple valve, because it vents brake-pipe air into the brake cylinder during an emergency application of the brake.

65. The operation of the quick-action cap is as follows: When the piston *3* strikes the graduating stem *5* in an emergency application, it compresses the graduating spring *6* and moves the slide valve *15* so as to uncover port *q*. Brake-pipe pressure then unseats the check-valve *16* and flows into chamber *s*, thence through passage *t* into the brake cylinders. When the brake-cylinder pressure and the tension of spring *17* becomes slightly greater than the brake-pipe pressure in the valve *16*,

the valve reseats and stops further flow of air through passage *t* into the brake cylinders.

When brakes are released, the graduating spring *6* returns the graduating stem *5* and valve *15* to normal position, closing the port leading to valve *16*.

PRESSURE-MAINTAINING FEATURE OF THE AUTOMATIC CONTROL VALVE

66. The **pressure-maintaining feature** of the automatic control valve is very valuable in connection with the L T equipment, for as long as there is air pressure in the control cylinder of the automatic control valve, the same amount of pressure will be maintained in the locomotive brake cylinders, regardless of the length of piston travel or the ordinary brake-cylinder leakage. This is due to the fact that the supply of air for the locomotive brake cylinders in automatic applications of the brake is taken from the main reservoir, and when the control piston *2* is in service-lap position, due to an automatic application, a leak that reduces brake-cylinder pressure will also reduce the pressure in the exhaust-valve chamber of the automatic control valve, which will cause the control piston *2* and exhaust valve *7* to be moved upwards by the greater pressure in the control cylinder. As the control valve is moved it will open the control valve and allow main-reservoir air to pass to the locomotive brake cylinders until the pressure in the exhaust-valve chamber, and consequently in the brake cylinders, is equal to that in the control cylinder, when the control piston will move the exhaust valve far enough for the control valve to close. This action of the automatic control valve will be repeated each time the leaks reduce brake-cylinder pressure below that in the control cylinder.

67. If there are any leaks from the control cylinder or reservoir of the automatic control valve, this maintaining feature will be destroyed, because, with the brakes applied and the automatic brake valve in lap position, the leak will continue to reduce the pressure in the control cylinder. This will allow

the greater pressure in the exhaust-valve chamber to move the control piston and its exhaust valve to release position and exhaust the locomotive brake-cylinder air. In such a case, however, it will be possible to hold the locomotive brakes on by placing the independent brake valve in application position.

INDEPENDENT STRAIGHT-AIR BRAKE

68. The **independent brake** is separate from the automatic brake and is entirely independent of that brake, a double check-valve, Fig. 1, being inserted in the brake-cylinder pipe between the straight-air pipe and the brake-cylinder pipe to separate the systems. The release pipe, Fig. 1, is the only connection between the independent brake valve and the automatic brake system, but the release pipe in no way affects the independent brake system. It is operated by means of the independent brake valve.

69. Locomotive Automatic Release by Independent Brake Valve.—If it is desired to release the locomotive brakes independently of the train brakes, it may be done by moving the handle of the independent brake valve to locomotive automatic release position. In this position, Fig. 25, the brake-valve handle opens the release valve and allows control-cylinder air to escape through the control-cylinder pipe, the release pipe, and the release valve of the independent brake valve. This reduces control-cylinder pressure, and the greater pressure in the exhaust-valve chamber forces the control piston upwards, as shown in Fig. 56. This opens the exhaust valve 7 and allows brake cylinder air to escape to the atmosphere.

Should it be desired to apply the locomotive brakes again, without making a further reduction of brake-pipe pressure, and thereby increase the braking force on the train, they can be applied and released by the independent brake valve, without disturbing the automatic control valve. Should this be done, the automatic control valve will remain in the position shown in Fig. 56, until it is returned to its normal position by the usual movements of the automatic brake valve for releasing

brakes, or a further reduction is made in brake-pipe pressure. If a further reduction of brake-pipe pressure is made to increase the braking force on the train, the triple piston, the slide and graduating valves and the control valve will again assume the position shown in Fig. 51.

BRAKE-PIPE VENT VALVE

DESCRIPTION

70. The **brake-pipe vent valve**, Fig. 57, is used with equipments in which the automatic control valve is supplied

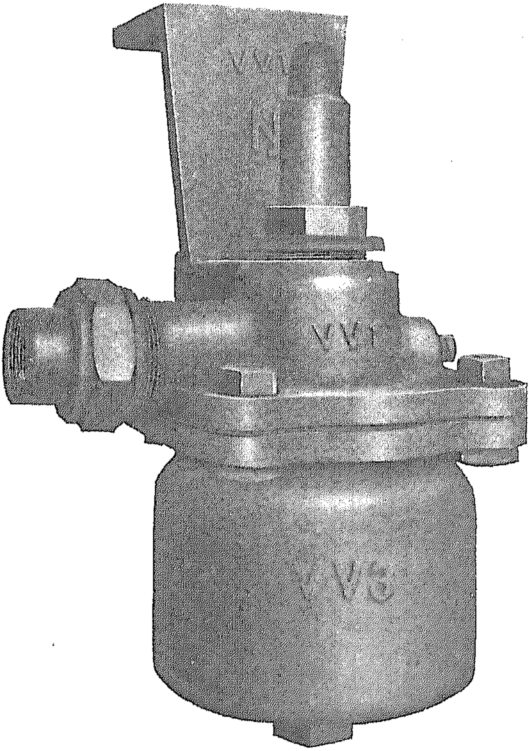

FIG. 57

with a plain cylinder cap. Its purpose is to vent brake-pipe air to the atmosphere in emergency applications, so as to insure

prompt serial action of the triple valves throughout the train. The vent valve is located in the automatic brake pipe on the tender, Fig. 2, about midway between the automatic brake valve and the triple valve on the first car.

The vent valve is preferable to a quick action cylinder cap, for the reason that it can be placed farther from the automatic brake valve. Thus, it more surely performs the duty for which it was designed.

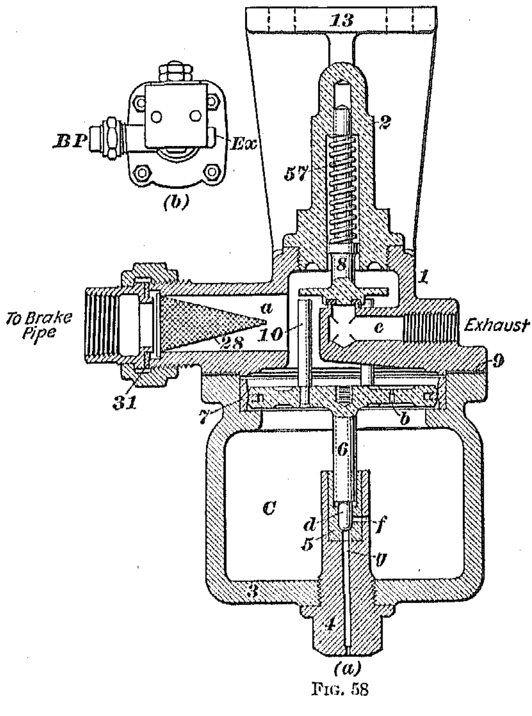

FIG. 58

71. The internal construction of the vent valve is shown in Fig. 58, in which *1* is the upper case; *2*, the upper-case cap nut; *3*, the lower case; *4*, the port; *5*, the port bushing; *6*, the vent piston; *7*, the piston bushing; *8*, the check-valve; *9*, the lower-case gasket; *10*, the lifting pins; *13*, the bracket; *28*, the strainer; *31*, the union gasket; *57*, the check-valve spring.

OPERATION OF BRAKE-PIPE VENT VALVE

72. Brake-pipe air entering chamber *a* above the vent-valve piston *6* passes through the small feed-port *b* into chamber *C*, charging chambers *a* and *C* to brake-pipe pressure. When the vent valve is fully charged, the weight of the vent piston *6*, assisted by the air pressure in chamber *a*, holds the relief valve *d* to its seat, while the vent valve *8* is held to its seat by the spring *57* and chamber *a* air pressure.

When an emergency brake-pipe reduction is made, either by means of the brake valve or in some other manner, the sudden reduction in chamber *a* pressure permits the pressure in chamber *C* to raise the vent piston *6*. The rising of piston *6* causes the lifting pins *10* to unseat the vent valve *8*, allowing brake-pipe air to escape to the atmosphere through the exhaust passage *e*. Also, as the stem of piston *6* rises, it unseats the relief valve *d* that connects the relief port *f* with the relief exhaust port *g*. This permits some of chamber *C* air to escape to the atmospere, and reduces chamber *C* pressure slightly below chamber *a* pressure when the vent piston is forced downwards by the greater pressure above it. The closing of the relief valve *f* allows the vent valve *8* to be reseated, thus closing the exhaust port *e* and stopping the escape of brake-pipe air to the atmosphere.

The capacity of the small feed-port *b* in piston *6* is such that in service applications air from chamber *C* can pass through port *b* into the brake pipe at the same rate that the brake-pipe pressure is being reduced. This maintains the pressure in chambers *a* and *C* equal and prevents the vent piston from being raised and thus opening the vent valve *8*.

DOUBLE PRESSURE CONTROLLER

DESCRIPTION

73. The style **J-2 double pressure control valve** used with the L T equipment is shown in perspective in Fig. 59, and

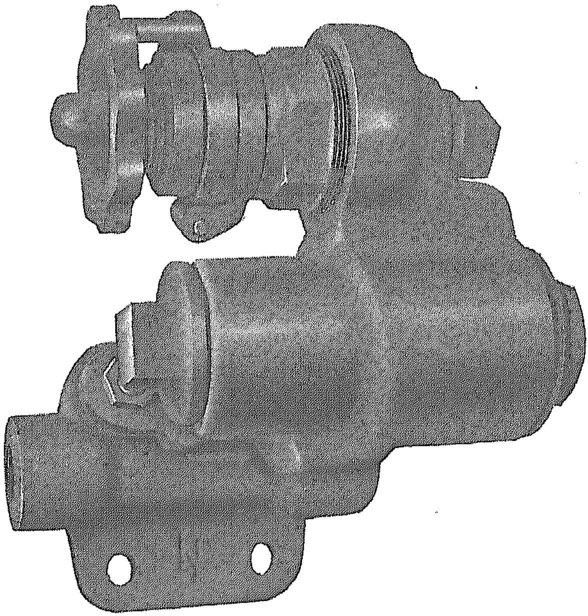

Fig. 59

in diagrammatic form in Fig. 60. It is connected to a pipe bracket located in the main-reservoir pipe, Fig. 1, between the reservoir and the automatic brake valve. It regulates the pressure in the feed-valve pipe and, also, in the brake pipe when the automatic brake valve is in running or holding position, and has a double-regulation feature, so that it can be quickly adjusted to change the regulated pressure from one standard pressure to the other. Thus, the duplex adjusting arrangement of the valve avoids the necessity of two single control valves in high-and-low pressure service.

This control valve has two sets of movable parts, those which operate in conjunction with the supply valve, and those which operate the regulating valve.

74. The names and numbers of the parts as shown in Fig. 60 are: *1*, supply piston ring; *2*, supply piston spring; *3*, supply piston; *4*, supply valve; *5*, graduating valve; *6*, graduating-

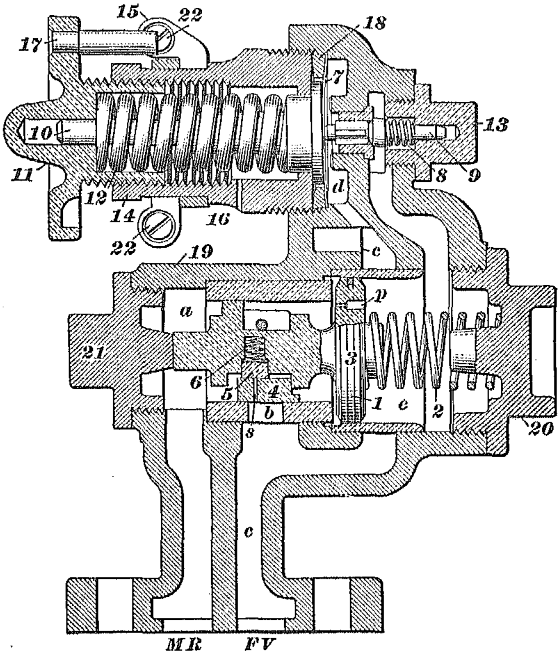

Fig. 60

valve spring; *7*, regulating diaphragm; *8*, regulating valve spring; *9*, regulating valve; *10*, diaphragm spindle; *11*, adjusting handle; *12*, regulating spring; *13*, regulating-valve nut; *14*, spring box; *15*, inner-hand wheel stop; *16*, outer-hand wheel stop; *17*, hand-wheel pin; *18*, diaphragm ring; *19*, body; *20*, supply cap; *21*, body cap; *22*, stop-screw.

OPERATION OF DOUBLE-PRESSURE CONTROLLER

75. The operation of the double-pressure controller, Fig. 61, is as follows: air from the main reservoir enters the control valve at the connection *M R* and charges chamber *a*, forcing the supply-valve piston *3* to the right against the resistance of the spring *2*. The piston first starts the graduating valve *5* and then the supply valve *4*, and moves these to the right until the

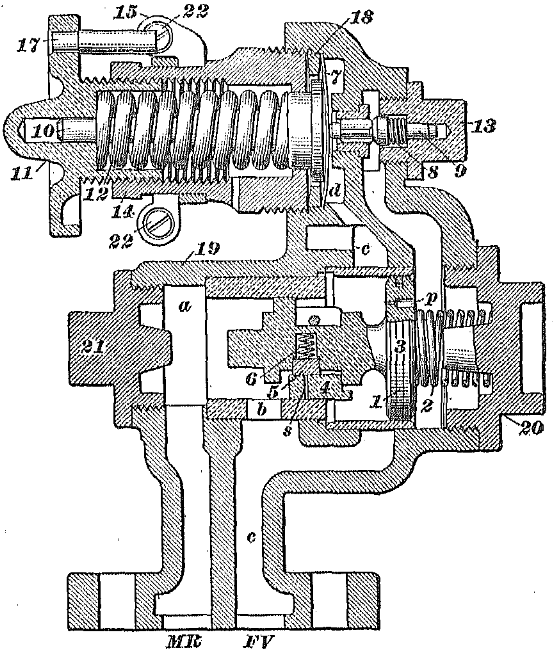

FIG. 61

supply port *b* is uncovered, as shown in Fig. 61. Port *b* opens into the passage *c*, one branch of which leads to the feed-valve connection *F V*, and the other branch to the diaphragm chamber *d*. Main-reservoir air feeds into the passage *c* until the pressure in chamber *d* on the diaphragm *7* is just sufficient to overcome the resistance of the regulating spring *12*, when the diaphragm and spring will be compressed and will allow the regulating valve *9* to close. Main-reservoir air

feeding through the port *p* in the supply valve piston *3* now equalizes chamber *e* and main-reservoir pressures, thus balancing the pressure on the two faces of piston *3* and allowing the piston spring *2* to move the piston to the left, closing the supply valve *4* and the graduating valve *5*. This stops the flow of main-reservoir air through port *b* into the passage *c*.

Any reduction in feed-valve pipe pressure produces a like reduction in pressure in the diaphragm chamber *d*. When the air pressure on the diaphragm, through leakage or otherwise, becomes slightly less than the pressure exerted by the regulating spring *12*, the spring forces the diaphragm to the right, opening the regulating valve *9*. This causes piston *3* to move far enough to the right for the graduating valve *5* to open the ports *s* in the supply valve *4*. There are five of these small ports *s* through the supply valve, and their capacity is sufficient to replenish the air loss through small leakages, therefore insuring a more uniform pressure in the feed-valve pipe. If a greater reduction is made in feed-valve pressure, and in chamber *d*, it will cause the supply-valve piston to move farther to the right and open the supply valve *4*, thereby admitting main-reservoir air, through port *b*, into the feed valve passage *c*. Air will flow into passage *c* until the pressure in the feed-valve pipe becomes normal, when the supply valve will be closed, as already explained.

ADJUSTMENT OF DOUBLE-PRESSURE CONTROLLER

76. The New York Air Brake Company advise adjustment for a high brake-pipe pressure of 110 pounds and a low pressure of 80 pounds. By turning the hand wheel *10*, Fig. 60, to the left until the stop-pin *17* strikes against the inner hand-wheel stop *15*, the tension of the regulating spring *12* is adjusted for the lower pressure, 80 pounds, to be carried. Turning the wheel clockwise until the pin *17* strikes the outer hand-wheel stop *16* increases the tension of the spring *12* and adjusts the controller for the higher pressure, 110 pounds, to be carried.

The stop *15* may be adjusted in position for increasing the lower pressure carried by loosening the stop-screw *22*, moving the stop *15* clockwise a sufficient amount, and then securing

the stop in place by tightening the screw *22*. Turning the stop counter clockwise reduces the pressure that will be carried for that stop. The stop *16* is adjusted for higher or for lower pressure in exactly the same manner.

The actual adjusting is done as follows: loosen the screw *22* and turn the adjusting wheel *11* until the supply valve *4* closes at the desired pressure; then move the stop into contact with the stop-pin *17* and fasten the stop securely by tightening the screw *22*.

SINGLE-PRESSURE CONTROLLER

77. A sectional view of the *reducing valve*, or **single-pressure control valve** is shown in Fig. 62. This valve is used for

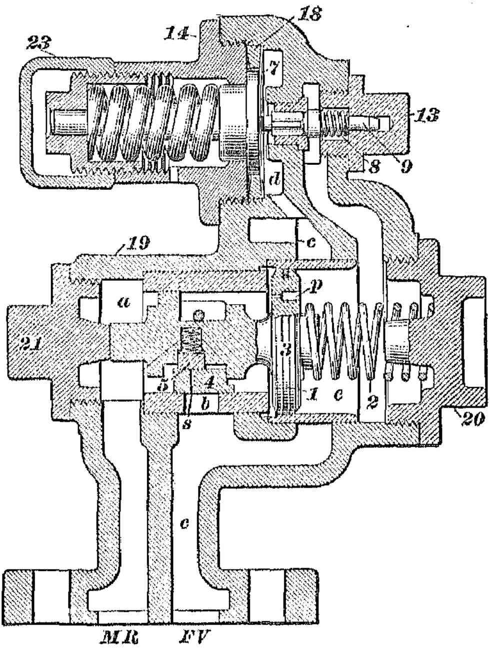

Fig. 62

controlling the pressure, for operating the independent brake, and for operating the signal system when desirable. The construction and operation of this valve is the same as that of

the double-pressure control, except that it does not have double-pressure adjustment features. It is adjusted to reduce main-reservoir pressure to 40 pounds for independent brake-pipe pressure.

78. **Regulation.**—If the reducing valve does not regulate the pressure to the proper amount, 40 pounds, it can be adjusted by means of the regulating nut, Fig. 62. If it maintains a pressure below 40 pounds, the regulating nut should be turned

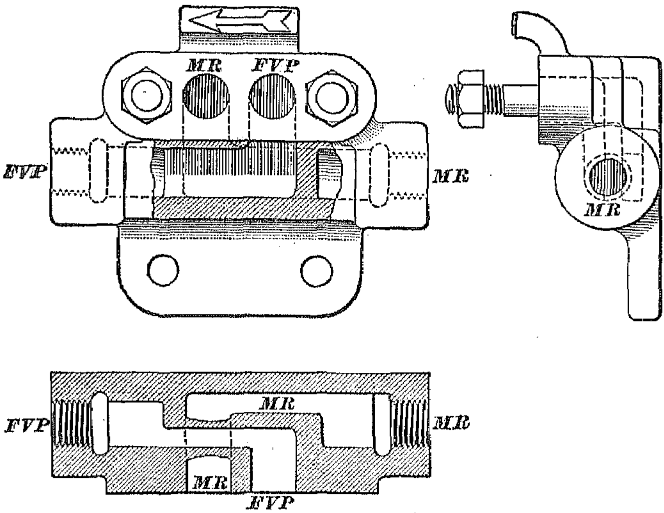

Fig. 63

slowly until the tension of the regulating spring is sufficiently increased to give the proper regulation. If it maintains a pressure greater than 40 pounds, the regulating nut should be turned so as to reduce the tension of the regulating spring the amount necessary to cause the valve to give the proper pressure.

In order to turn the regulating nut, the check-nut *23* must first be removed. After the regulating spring has been properly adjusted, the check-nut must be replaced.

FEED-VALVE BRACKETS

79. The standard style of feed-valve bracket regularly furnished, is shown in Fig. 63. In this style, the main-reservoir

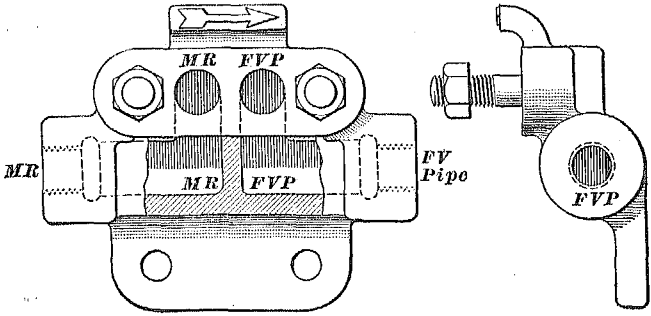

FIG. 64

pipe connects to the right of the bracket, and the passages are crossed, so that the air flows through the bracket, as indicated by the arrow.

In some piping arrangement, the pipes would have to be crossed in order to use the bracket shown in Fig. 63. The bracket shown in Fig. 64 is furnished when specified, to avoid crossing the pipes.

DUPLEX PUMP GOVERNOR

DESCRIPTION

80. The **style F X duplex pump governor** is used with the L T locomotive brake equipment. It performs the same duty as previous types of governors, and when used with the L T equipment and the type L brake valve is in running or holding position, it also provides a means of maintaining a moderate excess pressure in the main reservoir above that in the brake pipe, whether the brake-pipe pressure is high or low; also, it automatically increases the amount of excess pressure when the brake valve is in lap, service, or emergency position. It is not necessary to change the tension of the regulating spring

in the governor when the brake-pipe pressure is changed from one standard amount to another by the feed-valve, because the governor will automatically change the main-reservoir pressure

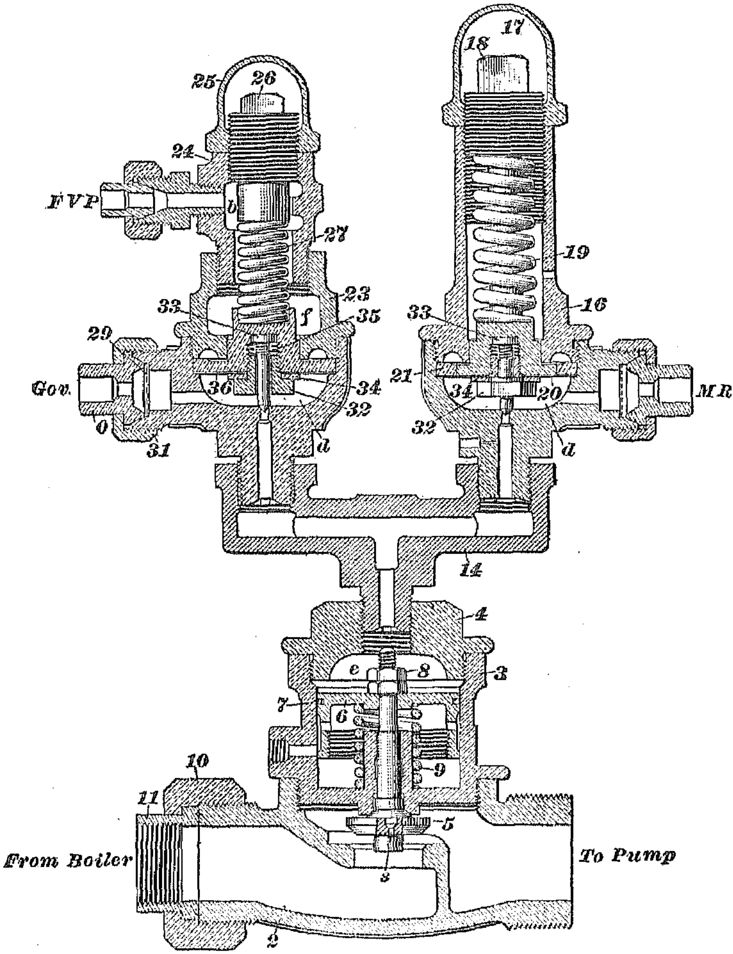

FIG. 65

to suit and still maintain the other features previously mentioned. The maximum-pressure head is piped directly to main-reservoir air on the main-reservoir side of the main-reservoir cut-out cock, Fig. 1. When the main-reservoir pressure raises

to the amount at which the maximum-pressure side of the governor is set, this side of the governor will operate the steam valve and stop the pump. The excess-pressure head controls the pump when the type L brake valve is in release, running, or holding position, and the maximum-pressure head controls the pump when this brake valve is in lap, service, or emergency position. This allows a moderate amount of excess pressure to be carried when brakes are released, which aids in reducing the labor of the pump; then, when the brakes are applied, the governor will allow the pump to increase the amount of excess pressure to insure their prompt release and recharge. With this governor, it is also possible for the engineer to raise and maintain the brake-pipe pressure about 20 pounds above that for which the feed-valve is set, simply by the use of the release position of the type L brake valve. This is a very important feature in controlling heavily loaded trains during the descent of steep grades.

81. Fig. 65 shows a sectional view of the F X pump governor used in connection with the piping arrangement shown in Figs. 2 and 3, and Fig. 66 shows a sectional view of the style F governor used in connection with the piping arrangement shown in Fig. 1. With the exception of the excess-pressure head of the F X governor, the construction and operation of the two governors is the same and they perform the same duty as previous type of governors.

The numbers and names of the various parts, Figs. 65 and 66, are as follows: *2*, steam-valve body; *3*, cylinder body; *4*, cylinder cap; *5*, steam valve; *6*, governor piston; *7*, piston-packing ring; *8*, piston nut; *9*, piston spring; *10*, union nut; *11*, union swivel, *14*, duplex fitting; *15*, diaphragm body; *16*, maximum-pressure-head spring box; *17*, maximum-pressure-head check-nut; *18*, maximum-pressure-head regulating nut; *19*, maximum-pressure-head regulating spring; *20*, maximum-pressure-head diaphragm; *21*, diaphragm rings; *23*, excess-pressure-head spring box; *24*, excess-pressure-head spring-box extension; *25*, excess-pressure-head check-nut; *26*, excess-pressure-head regulating nut; *27*, excess-pressure-head regulating spring; *29*, strainers; *30*, union

swivels; *31*, union nuts; *32*, diaphragm nuts; *33*, diaphragm valves; *34*, diaphragm washers; *35*, diaphragm-valve springs, *36*, excess-pressure-head diaphragm.

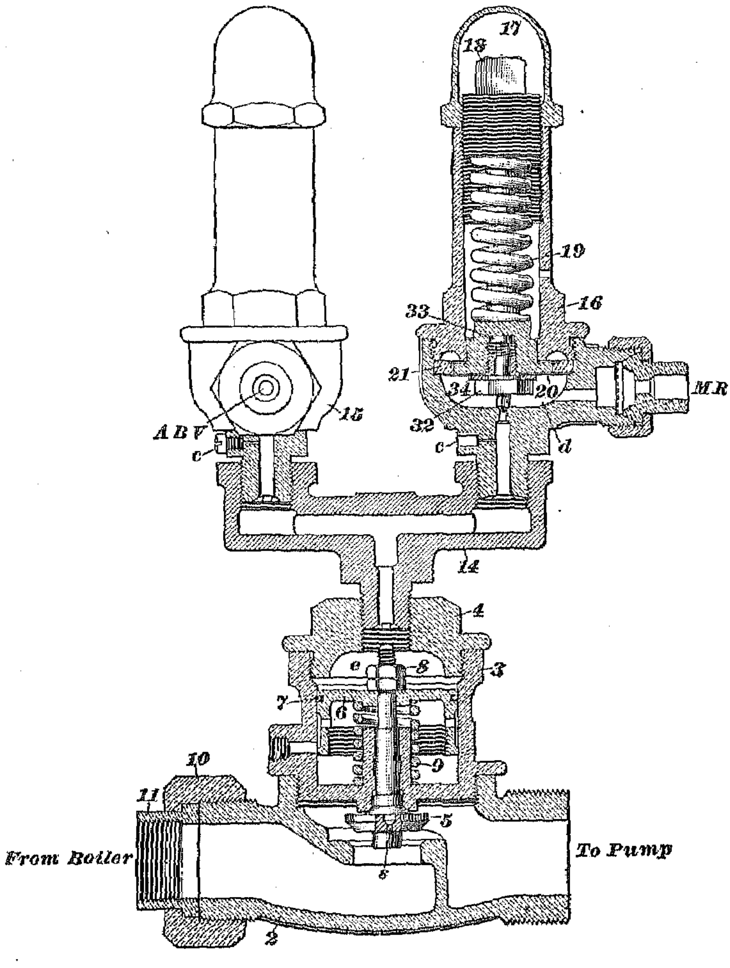

Fig. 66

Referring to Fig. 1, it will be observed that the connection *11*, Fig. 65, leads to the steam valve; *P*, to the air pump; *M R*, to the main reservoir; *Gov.*, to the L automatic brake valve; and

F V P, to the feed-valve pipe. The drip-pipe connection, also, is shown. In each governor head is provided a relief port to perform the same duty as the port *c* in previous types of governors; but, with the duplex governor, one of these ports is plugged to avoid unnecessary waste of air.

OPERATION OF DUPLEX PUMP GOVERNORS

82. By referring to the piping diagram, Fig. 3, it will be seen that there are two pipes leading to the excess-pressure side of the governor. Main-reservoir air from the L brake valve, when it is in release, running, or holding position, comes through pipe *Gov.* and passes through the governor fitting *Gov.*, Fig. 65, into chamber *d under* the diaphragm *36*. Air from the feed-valve pipe passes through the governor fitting *F V P*, into the chamber *above* the diaphragm *36*, called chamber *f*. The pressure in chamber *f* acts in conjunction with the regulating spring *27* to hold the diaphragm down. The tension of the regulating spring *27* can be regulated to change the amount of excess pressure by means of the regulating nut *26*. The main-reservoir pressure in chamber *d* tends to force the diaphragm *36* up and open the diaphragm valve *33*, while the pressure in chamber *f* and the spring *27* tends to hold the diaphragm down and the valve *33* on its seat. The tension of the regulating spring *27* is always added to that of the pressure in chamber *f* so that when the main-reservoir pressure in chamber *d* overcomes the air pressure in chamber *f* and the tension of the regulating spring *27*, the diaphragm will be raised, unseating valve *33* and thus allowing air to flow from chamber *d* through passage *b* into the chamber above the governor piston *6*. This moves the piston down and closes the steam valve *5*, thereby shutting off the flow of steam to the pump (except through the small port *s* in valve *5*) and preventing it from raising the main-reservoir pressure above the desired amount. Thus, when the main-reservoir pressure exceeds the brake-pipe pressure by an amount equal to the tension of the regulating spring *27*, the governor will operate, regardless of what the actual brake-pipe and main-reservoir pressures are.

83. When the L brake valve is moved to lap or application position, it cuts off the supply of air to chamber *d*; or, if from any cause the main-reservoir pressure is reduced so that the pressure in chamber *f* and the tension of the regulating spring *27*, combined, are greater than the pressure in chamber *d*, the diaphragm *36* will be moved down, closing valve *33* so that no more air can pass into the chamber above the governor piston *6*. The air in this chamber *e* then escapes through relief port *c*, and the spring *9*, assisted by the steam pressure under the steam valve *5*, forces the air piston and steam valve up to their full open position, admitting steam to the pump.

When the L brake valve is in lap, service, or emergency position, main-reservoir air feeds through the ports in the rotary valve and its seat into the feed-valve pipe and then through the excess-pressure governor pipe into chamber *f* in the excess-pressure governor, so that the diaphragm valve is held closed in these positions of the L brake valve.

When the L brake valve is in full-release position, the feed-valve pipe is cut off from the brake pipe and the pressure in the feed-valve pipe is maintained by the feed-valve. If there are no serious leaks into or out of the feed-valve pipe or the excess-pressure governor pipe, the pressure in these pipes will remain constant at the pressure for which the feed-valve is adjusted; conequently, the excess-pressure side of the governor will not stop the pump until the main reservoir pressure in chamber *d* is high enough to overcome the pressure in the feed-valve pipe and the tension of the regulating spring *27*; hence, by placing the L brake valve in full-release position, the brake-pipe and auxiliaries will charge up to the pressure in the main reservoir.

The amount of excess pressure carried is regulated by removing the check-nut *25* and adjusting the tension of the regulating spring *27* by means of the regulating nut *26*, after which the check-nut *25* is replaced.

COMBINED STRAINER AND CHECK VALVE

DESCRIPTION

84. The **D C strainer and check-valve,** used with the L T equipment in connection with the by-pass arrangement on a dead engine, or an engine with a disabled air pump, to pass air from the brake pipe to the main-reservoir pipe is shown in Fig. 67.

The numbers and names of the parts of the type D C strainer and check-valve are as follows: *2*, valve body; *3*, cap nut; *4*, check-valve; *5*, check-valve spring; *6*, valve cap; *7*, perforated strainers; *8* curled hair; *9*, union swivel; *10*, union nut; and *11*, union swivel seat.

OPERATION OF D C STRAINER AND CHECK-VALVE

85. When the D C strainer and check-valve, Fig. 67, is in use as a by-pass on a dead engine, brake-pipe air enters at

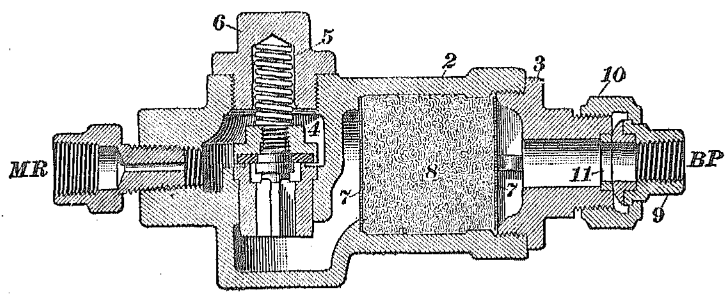

FIG. 67

the connection *B P* and passes through the strainers *7* and the curled hair *8* to the space under valve *4*. The spring *5* in the valve has a tension that will hold check-valve *4* on its seat until the pressure below valve *4* is about 20 pounds higher than that above it. With a pressure of 70 pounds in the brake pipe, the spring *5* will allow a pressure of about 50 pounds in the main reservoir on a dead engine to operate its brakes by means of the distributing valve.

The choke plug in the outlet *M R* prevents air from flowing out of the brake pipe so fast as to interfere with the release of the train brakes or cause them to stick. The check-valve *4* prevents any air from passing back into the brake pipe from the main-reservoir pipe when a brake-pipe reduction is made, so that the operation of the train brakes will not be interfered with. The purpose of the cut-out cock used with the by-pass is to cut out the by-pass arrangement when the air pump on that engine is furnishing air for its own brakes.

CARE, MAINTENANCE, AND DEFECTS

BRAKE VALVE

86. Brake-Valve Handle Works Hard.—If the handle of the automatic brake valve does not operate easily, the rotary valve or the rotary-valve key gasket is probably dry from lack of lubrication. To remedy this trouble when the brake system is charged, close the double-heading cock in the brake pipe below the brake valve; also, close the main-reservoir cock in the main-reservoir pipe. Operate the brake valve to remove all pressure from it; then, remove the oil plug in the automatic brake-valve body, fill the hole with good valve oil, and move the brake-valve handle from full-release to emergency position and back to release position a few times, to work the oil between the rotary and its seat. Again fill the oil hole and replace the plug. Next, remove the cap nut from the top of the rotary-valve key, fill the hole in the key with oil, push down on the key, and move the handle a few times; then, again fill the hole with oil and replace the cap nut.

87. Brake-Valve Test.—To test for a leaky rotary valve in the automatic brake valve, close the cut-out cock in the brake pipe below the brake valve, place the automatic brake-valve handle in lap position, and start the pump. A leak past the rotary valve into the brake pipe will be indicated by a blow at the brake-pipe exhaust port or by the black hand on the large

air gauge moving up. If the rotary valve or the valve-seat lower gasket allows main-reservoir air to leak into chamber *D*, it will be shown by the black hand on the large air gauge moving up, but it will not cause a blow at the brake-pipe exhaust port.

To make the test when the brake system is charged, place the brake-valve handle in service position and discharge all the air from the brake pipe; then, close the cut-out cock in the brake pipe under the brake valve and place the brake-valve handle in lap position. If a blow starts at the brake-pipe exhaust port, it indicates a leak past the rotary valve into the brake pipe; if the black hand on the large air gauge shows an increase in pressure, it indicates a leak past the rotary valve or the valve-seat lower gasket into chamber *D*. If the brake-cylinder gauge shows an increase in pressure, or if an intermittent blow occurs at the safety valve on the automatic control valve, it indicates a leak into the port or passage leading to the automatic control-valve cylinder pipes.

88. If, with the automatic brake valve in release, running, or holding position, there is a constant blow at the brake-pipe exhaust port, it indicates that the brake-pipe exhaust valve is held from its seat by foreign matter or that the valve or its seat is cut. If the trouble is due to the former cause, it may be possible to dislodge the foreign matter by tapping the brake valve while making a service application or by removing the exhaust plug and using a thin, pointed piece of wood to remove the dirt. If the trouble is due to the valve or its seat being cut, the equalizing valve and its seat will have to be reground.

89. To determine whether a leak is from the brake valve or from the automatic control valve, open the unions in the pipes leading from the brake valve to the automatic control valve after placing the brake-valve handle in lap position; *then if air blows out of a pipe at the open union when the port* leading to that pipe should be closed, it will locate the leak.

Usually, an inspection of the brake valve will be necessary to determine whether the leak is across the body gaskets or past the rotary valve. If the leak is supposed to be from the

brake pipe or from chamber *D* into one of the pipes, discharge all the air from the brake pipe by placing the automatic brake valve in service position, and then place the brake-valve handle in lap position; if this stops the leak at the open union and it begins again when the brake pipe is charged up, look for a leak past the body gaskets.

If the duplex pressure controller is dirty or gummed up and there is an excessive brake-pipe leakage, the sluggish action of the controller might allow brake-pipe pressure to reduce 4 or 5 pounds before it opens to supply the leakage. This would probably cause the locomotive brakes to apply each time the duplex-pressure controller closed and to release again when the controller opened, producing a mild blow at short intervals at the emergency-exhaust port of the automatic brake valve while the automatic brake valve is in running position. The fluctuation of the black hand on the small air gauge will indicate the opening and closing points of the duplex-pressure controller.

90. If the air from either the main reservoir or the brake pipe can leak into the control cylinder or reservoir of the automatic control valve, it will make a steady blow at the emergency-exhaust port of the automatic brake valve when the slide valve *4* in the automatic control valve is in release position and automatic brake valve is in running position.

A blow at the emergency-exhaust port of the automatic brake valve while it is in running position might be due to a leak past the slide valve in the automatic control valve, a leak past the gasket between the automatic control valve and its divided reservoir, or a leak past the rotary valve in the brake valve. To locate the cause for this blow, cut out the main-reservoir and brake-pipe air from the automatic control valve and drain all the air from the automatic control valve. Then, if the blow continues, it must come from the brake valve; but if the blow stops, look for the cause in the automatic control valve.

91. Leak From Passage M R Into Chamber D.—If the gasket between the rotary-valve seat and the bottom case of the brake valve leaks so that air can pass from passage *M R*

into chamber *D* equal to or greater in volume than the discharge through the preliminary-exhaust port *e*, no reduction in chamber *D* pressure can be made with the rotary valve in service position and the equalizing piston will not rise; hence, no reduction in brake-pipe pressure will be made and no excess pressure will be indicated by the large air gauge. If, in addition to this leak, air can leak past the equalizing piston into the brake pipe, it will increase the brake-pipe pressure and tend to release the brakes when the brake valve is in lap position after the brakes have been applied.

SINGLE-PRESSURE CONTROLLER

92. In order to obtain the best service from the independent-brake applications, it is important that the single-pressure controller be kept clean and properly adjusted. If it leaks or is adjusted for a pressure that is too high, the pressure in the locomotive brake cylinders may be increased above the desired amount when independent-brake applications are being made. If it is adjusted for a pressure that is too low, the pressure in the signal system and for use in the independent brake valve will not be raised to the amount necessary to obtain the best service. If, when the main reservoir is charged, the independent brake valve is held in application position, the red hand on the small air gauge will indicate approximately the pressure for which the single-pressure controller is set.

AUTOMATIC CONTROL VALVE

93. In order that the automatic control valve may work properly, the valves and pistons must be kept well lubricated and free from dirt. The automatic control valve and its reservoir should be regularly drained, and the pipe connections should be kept tight. If the automatic control valve is to be repaired or cleaned and tested, it should be removed from the double-chamber reservoir. This is done by removing the nuts from the reservoir studs. As all the pipe connections are made to

the double-chamber reservoir, removing the valve in this manner will not interfere with the pipe joints. If the gasket between the automatic control valve and the reservoir becomes torn or injured while removing the valve, a new one must be supplied, as a very slight leak across this gasket, from one port to another, will interfere seriously with the operation of the valve. When the pipes are first installed or when new ones are applied, they should be blown out with steam or compressed air before the valves are attached so as to clear them of foreign matter.

If the automatic control valve becomes dry from lack of lubrication, or if it becomes corroded or very dirty, a greater difference of pressure will be required to overcome the excessive friction and to operate the movable parts.

If the pipes and passages become corroded or very dirty, the engine brakes will not apply and release so promptly as when they are clean. If the engine brakes fail to apply when the brake system is fully charged and a 5-pound service reduction is made, the trouble is most likely due to excessive friction in the working parts of the automatic control valve, which should then be removed, cleaned, and lubricated. Sometimes the triple-valve piston packing ring sticks in its groove and prevents the piston from being moved by variations in brake-pipe pressure.

94. Effects of Leaks.—When testing for automatic control-valve leaks or for leaks into the pipes leading to this valve, 70-pound brake-pipe pressure should be used, as with this pressure the point where the leak is occurring can be more easily determined than if a brake-pipe pressure of 110 pounds is used. If air discharges from the exhaust port of the automatic control valve when the brake is applied, look between the automatic control valve and the brake valve for leaks that will reduce the pressure in the control cylinder. If the brake leaks off without this blow, there are leaks from both the control cylinder and the brake cylinders. To test for these leaks, apply the brake in full and try all the joints with the flame of a torch, or, if possible, apply soap suds to the suspected parts.

A leak in the control cylinder, control-cylinder gasket, or any place that will allow control-cylinder pressure to escape to the atmosphere will allow the control piston to move the exhaust valve *7* so as to exhaust brake-cylinder air. This may take place during a graduated application with the automatic brake valve, but not if the automatic brake valve is placed in emergency position.

95. If, after an automatic application has been made, the brake releases when the automatic brake valve is placed in release or holding position, look for a leak from the control cylinder or its connections between the automatic control valve and the brake valve. A leak in the control-cylinder pipe, cap, or cap gasket will allow an automatic application to release.

A leak into the control-cylinder pipe will build up a pressure in the control cylinder and cause the control-valve to apply the brakes when the automatic brake valve is lapped; or, during a graduated application, the brakes will apply harder. These leaks may occur at the brake valve, across the automatic control-valve gasket into the control reservoir, or under the slide valve *4*.

A leak out of the retain pipe will not affect the action of the automatic control valve during an automatic application, because the port leading to this pipe is then lapped by the triple slide valve.

96. To locate the trouble if the brake-cylinder pressure increases after a partial-service application is made, charge the brake system and make a 10-or 12-pound service reduction with the automatic brake valve; then lap the valve and note the pressure on the brake-cylinder gauge. If the brake-cylinder pressure increases to 50 pounds and remains constant, it is very apt to be due to brake-pipe leakage. Brake-pipe leakage in the automatic control valve may be due to a defective triple-cylinder-cap gasket; or, if a quick-action cylinder cap is used, it may be due to a defective slide valve *15*. A continued leak from the auxiliary reservoir into the control chamber would tend to increase brake-cylinder pressure; also, this leak would tend to cause the triple-valve piston of the

automatic control valve to move to release position; but the brake would not release, because the automatic brake valve would have the exhaust closed.

If the brake-cylinder pressure rises even above the equalizing point—50 pounds pressure—and a discharge of air is heard at the safety-valve exhaust, it indicates a leak of main-reservoir air into the control cylinder. This may be due to a leaky rotary valve in the automatic brake valve allowing main-reservoir air to get into the port that leads to the control-cylinder pipe, or to a leak past the gasket that is between the automatic control valve and its reservoir.

97. If air can leak from either the main reservoir or the brake pipe to the control cylinder or chamber, it will tend to cause a steady blow at the emergency-exhaust port of the automatic brake valve, provided the brake valve is in running position. When not in running position, it will build up a pressure and apply the locomotive brakes. A steady blow at that port, therefore, when the brake-valve is in running position usually denotes a leaky slide valve *4*. However, the leak may be due to a defective brake valve or a defective gasket between the automatic control valve and its reservoir. To locate the cause of this blow, close the automatic control-valve cut-out cock in the main-reservoir supply pipe and the double-heading cock under the brake valve to prevent any air from entering the automatic control valve from these sources, then drain all air from the automatic control valve. If the blow continues, the air is coming from the brake valve. If it stops, the cause of the blow will be found in the automatic control valve; or, the part that is at fault can be discovered by disconnecting the control-cylinder pipe at the union near the automatic control valve. If air escapes from the pipe that is attached to the valve, the valve is at fault; if it escapes from the automatic control-valve connection, the fault is with the control valve.

Brake-pipe leaks will have the same effect on the automatic control valve that they have on a triple valve; that is, they will apply the brake harder when the automatic brake valve is in lap position.

98. Broken Triple-Valve-Piston Graduating Spring. If the locomotive brake applies quick-action when only a partial service application is made and the brake-cylinder gauge shows a pressure of 50 pounds, look for a broken triple-valve-piston graduating spring.

99. Leaky Graduating Valve.—A leaky graduating valve will affect the operation of the automatic control valve only during a graduated-automatic application. It will then tend to cause the triple-valve piston, slide valve, and graduating valve to move to release position; but the brake will not release, because the automatic brake valve is in lap position and thus prevents the escape of control-cylinder air. If the brake pipe leaks an equal amount, the brake will continue to apply harder until the pressure in the control cylinder and chamber equalizes with that in the auxiliary reservoir. In order to allow the triple-valve piston to move to release position, the auxiliary reservoir-chamber pressure must reduce faster than brake-pipe pressure.

BROKEN OR LEAKY PIPES

100. To obtain the best results from the L T equipment, it is necessary that all pipe joints be kept tight and free from leaks, because leaky or broken pipes will either interfere with the operation of the locomotive brakes or prevent their operation. In some cases, when serious leaks develop or pipes are broken off, the pipes may be plugged or blind joints may be made in the unions to prevent the escape of air and the brake then operated with other pipes.

101. Main-Reservoir Pipe.—A leak in the main-reservoir pipe will not interfere with the operation of the brakes, provided the pump can furnish sufficient air to overcome the leak. If this pipe should break off at a point between the main reservoir and the pipe connection x, Fig. 2, that leads to the pipe E, it will prevent the operation of either the locomotive or the train brakes, since it cuts off the air supply from the brake system.

If the pipe breaks between this connection x, Fig. 2, and the supply pipe E, it will cut main-reservoir air off from the control valve and the automatic brake valve. Plug the broken pipe and close the supply pipe cut-out cock. The locomotive brake cannot be operated by means of the automatic brake valve but can be operated by means of the independent brake valve. The train brakes can be operated by the automatic brake valve, but cannot be recharged from release position. They can be operated from running position, however, as the main-reservoir pipe to the double-pressure controller is still intact.

If the main-reservoir pipe is broken between the double-pressure controller connection and the connection x, plug the pipe and carry the automatic brake valve in release position. Both the double-pressure and the single-pressure controllers will be out of commission, and the locomotive brake cannot be applied with the independent brake valve. The pump governor maximum-pressure top should be adjusted to the brake-pipe pressure desired.

102. Supply Pipe E.—If the supply pipe breaks off between the main-reservoir connection y, Fig. 2, and the supply-pipe cut-out cock, the opening in the pipe can be plugged to prevent loss of main-reservoir air, and the locomotive brake can be operated in conjunction with the train brakes by means of the independent brake valve.

If the supply pipe E breaks off between the connection y and the automatic brake valve it renders the train brakes inoperative. Plug the broken pipe to retain main-reservoir pressure, close the cut-out cock and operate the locomotive brake by means of the independent brake valve.

103. Double-Pressure Controller Pipes.—If the feed-valve pipe from the automatic brake valve to the double-pressure controller breaks, loosen the hand-wheel stops of the pressure controller and turn the hand wheel so as to relieve the regulating spring of all pressure. This will prevent the loss of main-reservoir air through the broken pipe. Carry the automatic brake valve in release position, and adjust the

pump-governor maximum-pressure top for the brake-pipe pressure desired.

If the branch pipe from the main-reservoir pipe to the double-pressure controller breaks, plug the pipe to prevent loss of main-reservoir air, carry the brake valve in release position, and adjust the pump-governor maximum-pressure top for the brake-pipe pressure desired.

104. Single-Pressure Controller Pipes.—If the main-reservoir pipe to the single-pressure controller breaks, plug the pipe to prevent loss of air. If the reducing-valve pipe breaks, unscrew the regulating nut so as to relieve the regulating spring of pressure and thus close the pressure controller. Either break cuts off the air supply from the independent brake valve, so that the locomotive brake cannot be set "straight air."

105. Pump-Governor Pipes.—If the governor pipe *H*, Fig. 2, to the maximum-governor head should break, the pipe should be plugged or mashed together on the main-reservoir side. Under these circumstances, the maximum governor head would be rendered inoperative, and if the brake valve were to be left in lap service or emergency position for a considerable length of time, the main-reservoir pressure would be raised to nearly boiler pressure unless the pump was throttled. This break does not effect the operation of the excess-pressure head of the governor.

If the pipe *Gov.*, from the the governor to the automatic brake valve should break, the pipe on the brake valve should be plugged or mashed together, and the maximun pressure head allowed to control the pump.

Should the excess-pressure governor pipe break, plug or mash together the pipe connected to the feed-valve pipe, and screw down on the excess-pressure-head regulating nut until the pin valve of that head is held to its seat against the pressure under its diaphragm. Adjust the maximum-pressure-governor head to give the pressure desired.

106. Retain Pipe.—If the retain pipe breaks, nothing need be done, as the "holding feature" of the locomotive brake

will simply be lost. This can be compensated for by the use of the independent brake valve.

107. Control Cylinder Pipe.—If the control-cylinder pipe breaks off, plug the piece attached to the automatic control valve and handle the automatic brake valve to apply and release or hold the driver brakes on in the usual manner. This pipe breaking off will destroy the locomotive automatic release feature of the independent brake valve, and also the pressure maintaining feature of the automatic brake valve in emergency position.

108. Release Pipe.—If the release pipe breaks, plug the end connected to the control-cylinder pipe. This break will simply cut out the locomotive automatic-release feature of the independent brake valve.

109. Brake-Cylinder Pipe.—If the brake-cylinder pipe leading from the control valve to the double-check valve breaks, the control valve will be rendered inoperative and the locomotive brakes will have to be operated with the independent brake valve. The supply-valve cut-out cock should be closed.

If the brake-cylinder pipe breaks between the double-check valve and the brake cylinders, it will render those brake cylinders inoperative. The brake-cylinder pipe attached to the double check-valve should be plugged so that the other brake cylinders not effected by the break may be operated by either brake valve.

If the brake-cylinder pipe between a brake cylinder and its cut-out cock bursts, close the cut-out cock to that cylinder and proceed, as the remaining cylinders will be operative.

110. Brake-Pipe Connection.—If the brake-pipe connection *B P*, Fig. 1, that connects the brake pipe with the control valve breaks off, the control valve cannot be operated by the automatic brake valve to apply and release the locomotive brakes. Close the cock in the brake-pipe strainers and cut-out cock and use the independent brake valve to operate the locomotive brake in conjunction with the train brakes. Also, close the supply-pipe cut-out cock so as to cut off main-

reservoir air from the control valve, and drain the control valve reservoir by placing the independent brake valve in locomotive automatic-release position.

111. Straight-Air Pipe.—If the straight-air pipe breaks, the locomotive brake cannot be operated "straight air" by means of the independent brake valve. No temporary repair will be necessary for a break of this kind.

112. Dead-Engine Fixture Pipe.—If the dead-engine fixture pipe should break between the strainer and the check-valve and the cut-out cock in the pipe is closed, nothing need be done, as no leaks can occur. If the break is between the cut-out cock and the brake pipe, or between the strainer and cut-out cock and the main-reservoir pipe, plug the end of the broken pipe from which air escapes.

113. Gauge Pipes.—In the event of any of the pipes to the air gauges breaking, simply plug the pipe from which air escapes.

114. Equalizing-Reservoir Pipe.—In the event of equalizing-reservoir pipe breaking, the equalizing feature of the automatic brake valve will be destroyed. Plug the broken pipe and the brake-pipe exhaust port of the automatic brake valve, and use the brake valve by carefully moving the handle to emergency position for applying the brake, and moving slowly back to lap position.

F-3 AND F-4 FEED VALVES

115. Views.—A view of the type F-4 feed-valve connected to the brake valve is shown in Fig. 68, and in Fig. 69 the parts are shown in section. The mounting of this feed-valve on the H-6 brake valve requires it to be supplied with a type-A pipe bracket. This bracket is furnished with a bolting flange and has a passage for conveying main-reservoir air to the feed-valve as well as one that conveys the air from the feed-valve to the rotary valve seat. The type-A pipe bracket dispenses with the feed-

valve pipe and the feed-valve bracket used with a type-B bracket.

The F-3 and F-4 valves are identical except that the latter is provided with adjustable stops for double-pressure control.

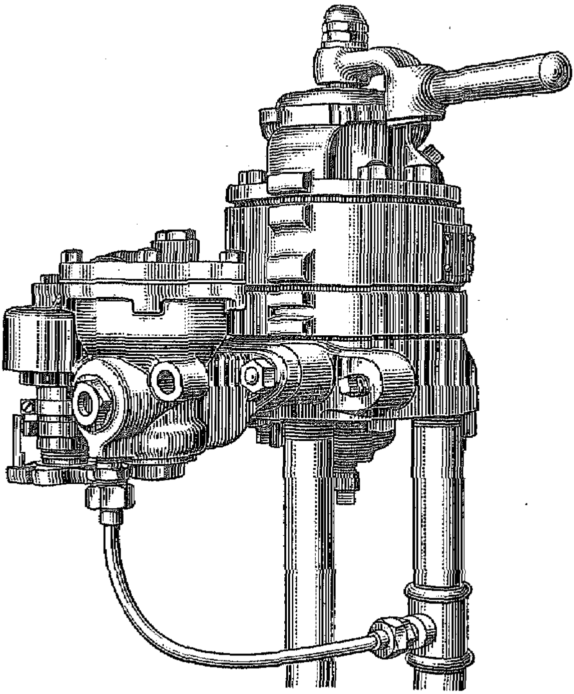

Fig. 68

116. Operation.—With the feed-valve in open position, Fig. 70, the air from the main reservoir enters through passage *a* and passes through passage *b* to the brake pipe. After entering the brake pipe some of the air returns to the feed-valve through the control pipe and then passes through passage *c* and exerts a pressure on the diaphragm *54*. The space *d* in front of the piston *36* is open to the atmosphere through the restricted choke *e*, passage *f*, and port *g*. When the pressure in the brake pipe and in passage *c* increases to slightly more than the tension of the regulating spring *64*, the diaphragm is deflected downwards, thereby unseating the pin valve *55*. The air in passage *c* now passes through passage *h* and overcoming the discharge capacity

of the choke *e* forces the piston *36* downwards and the valve *19* closes. The passage of air from the main reservoir to the brake pipe then stops. In closed position, Fig. 71, the air in the brake

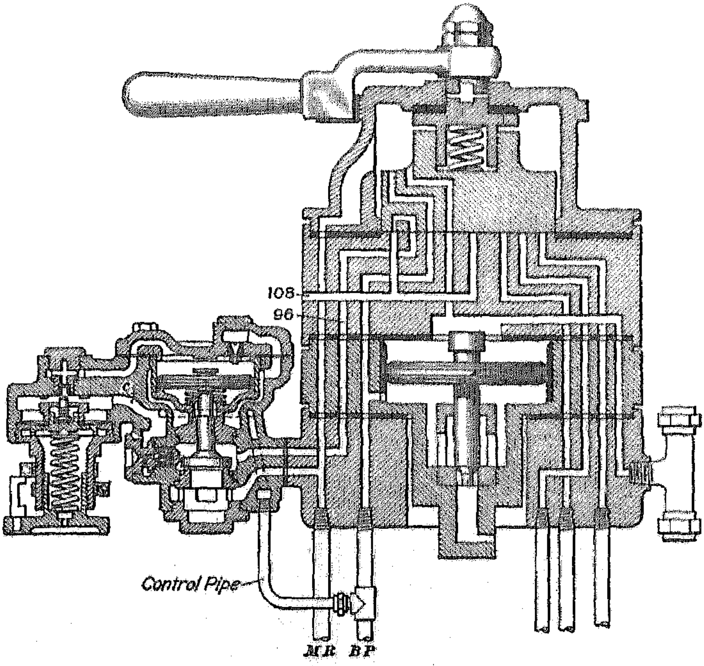

FIG. 69

pipe that is escaping by the unseated pin valve will continue to blow out of the port *g*. However, the discharge by the choke *e* is less than by the pin valve when it is fully opened and the piston *36* keeps the valve *19* seated. When the pressure in the brake pipe is reduced below the tension of the regulating spring *64*, the spring expands and the pin valve *55* seats. The air in front of the piston *36* passes through the choke and port *g* to the atmosphere, and the piston *36* and the valve *19* are then returned to normal position by the spring *42*. Air again passes from the main reservoir to the brake pipe.

117. Ball Check.—The plug in which check *50* sets is ported to permit air from the brake pipe to pass through the

warning port of the brake valve when in full-release position. Without this plug, the passage of air would stop in full-release position and in the absence of the warning sound of the air, the brake pipe might be overcharged. With the brake valve in full-release position, Fig. 69, the main reservoir is connected to the brake pipe and the main-reservoir air in the control pipe and in passage *c* causes the feed-valve to close. The small volume

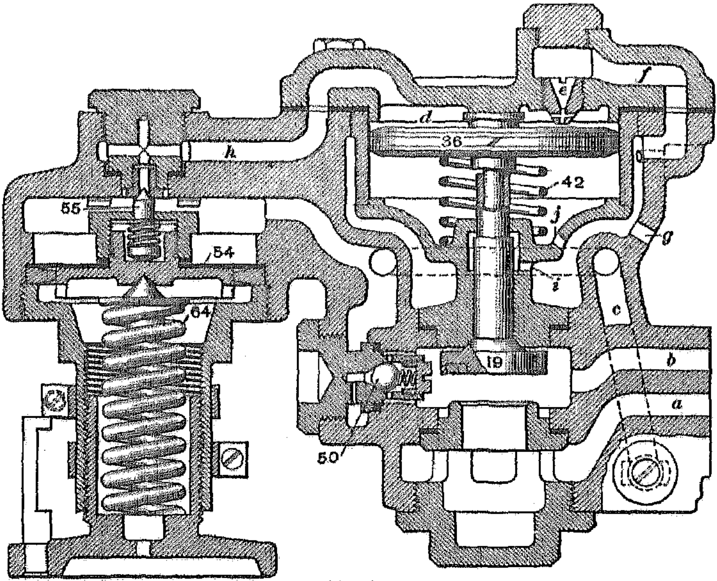

Fig. 70

of air in passage *96* in the brake valve would then escape quickly through passage *108* and the warning port and the blow would stop, were it not for the air from the brake pipe that forces the ball check from its seat against the spring pressure and passes through passage 96 to the warning port. The ball check prevents the passage of main-reservoir air to the control pipe and brake pipe with the valve *19* open.

Such a leak would then be objectionable if the brake valve was in lap position after a service application because the increase in brake-pipe pressure might tend to release some brakes. This disorder will be noticed especially with a light engine and a

comparatively tight brake pipe. The increase in brake-pipe pressure will force the equalizing piston upwards and a blow will occur at the brake-pipe exhaust port.

118. Remote-Control Feature.—Owing to the restriction offered to the flow of air by the passages in the brake valve, the pressure in the feed-valve passage in running position may

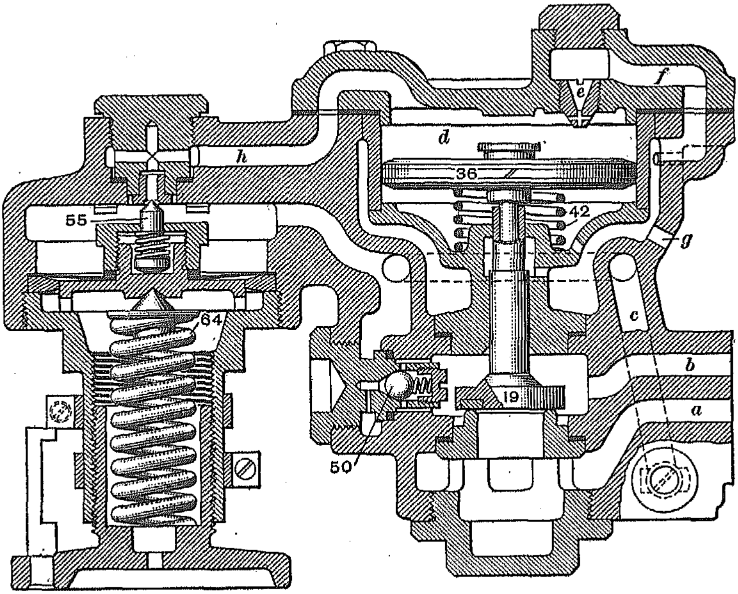

FIG. 71

at times be considerably higher than that in the brake pipe. Therefore, if the pressure in the feed-valve passage was used to control the feed valve, the valve would sometimes close before the pressure in the brake pipe reached standard. However, by piping the control pipe to the brake pipe, the valve will not close before the required pressure has been obtained, regardless of what the pressure may be in the feed-valve passage. This feature is known as remote control as opposed to internal control where the feed-valve is controlled by the pressure in the feed-valve passage in the brake valve.

When the control pipe breaks, air is prevented from entering the feed valve to shut it off. The following method can be used to admit air to the control portion of the valve: Plug the tee connection on the brake pipe, also the connection at the feed-valve, then remove the nut and take out the ball valve and spring. The valve then operates the same as any other internally controlled feed-valve.

119. Vent Ports.—Any leakage that occurs by the stem of the piston *36* is vented through port *i*, Fig. 70, and passage *f* to the atmosphere. The port *j* below the piston also vents any leakage by it to passage *f*.

NO. 5B COMPRESSOR

120. Construction.—A sectional view of the No. 5B compressor is given in Fig. 72. It consists essentially of a centerpiece *35* to which the cylinders are secured by the tap bolts shown. The upper casting contains the low-pressure air cylinder *2* and the high-pressure air cylinder *1*; the lower casting contains the two steam cylinders. The high-pressure air piston *31* and the low-pressure air piston *32* are connected by piston rods *18* to the pistons in the steam cylinders.

121. Operation of Steam Cylinders.—With the compressor at rest all pistons settle to the bottom of their cylinders and the tappet plates *20* on the steam pistons strike the shoulders on the valve rods *8* and force the valves *5* and *6* down. The steam enters *A* and passing through passage *26* to the cylinder *3* forces the piston *21* upwards. The air above the piston passes through passage *28* and a cavity in the valve *5* to the exhaust passage *D*. The steam also passes through passage *23* to the cylinder *4*. As the piston *21* nears the end of its up stroke the upper side of the tappet plate engages the button on the valve rod and pulls it and the valve *6* upwards. The piston now stops because the valve *5* is still in the same position as when the piston started its upward movement. However, with the valve *6*

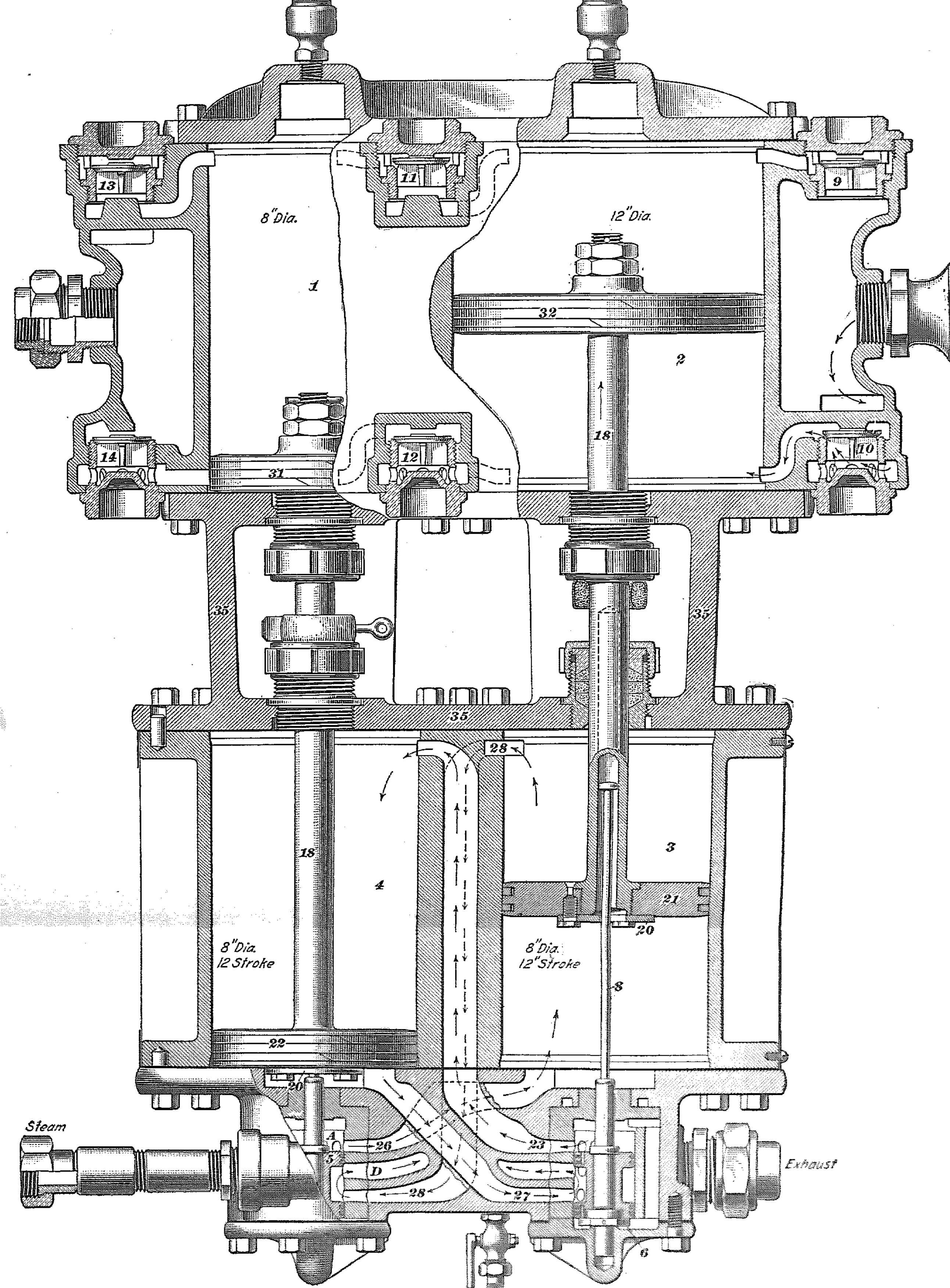

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Fig. 72

in its up position the upward movement of the piston *22* begins because steam is admitted through passage *27* to the lower end of the cylinder while the steam above the piston escapes through passage *23*, and the cavity in the valve *6* to the exhaust passage. When the piston *22* about completes its stroke the under side of the tappet plate strikes the button on the end of the valve rod and pulls it and the valve *5* upwards. The piston then stops because the position of the valve *6* remains unchanged. However, the upward position of valve *5* starts the piston *21* moving downwards because the steam now enters the upper end of the cylinder through passage *28* and the lower end of the cylinder is connected through passage *26* and the cavity in the valve *5* to the exhaust passage *D*. When the piston *21* nears the end of its downward stroke, the piston stops after the tappet plate has struck the shoulder on the valve rod and moved it and the valve *6* down. The piston *22* then starts to move down, owing to the admission of steam above the piston through passage *23*, and the exhaust of steam from beneath the piston through passage *27* the cavity in the valve *6* and the exhaust passage. As the piston *22* completes its downward stroke it shifts the valve to its down position and the piston 21 starts upwards.

The foregoing shows that only one piston is moving at a time; that is, after one piston makes a stroke it stops and does not start until the other piston completes a stroke. It will also be noted that valve *5* controls the movement of the pistons *21* and *32* and valve *6* the movement of pistons *22* and *31*.

122. Operation of Air Cylinders.—As the low-pressure air piston *32*, Fig. 72, moves upwards a partial vacuum forms beneath it and the air that enters through the air strainer lifts the inlet valve *10* and fills the low-pressure air cylinder. The air above the piston lifts the intermediate discharge valve *11* and enters the high-pressure air cylinder. The piston *32* then stops and, as the high-pressure piston *31* moves up, the air above it holds the valve *11* closed and passes to the main reservoir by unseating the final discharge valve *13*. As the high-pressure air piston moves up, a partial vacuum forms beneath it and the air in the low-pressure air cylinder lifts the intermediate dis-

charge valve *12* and passes to the high-pressure air cylinder. However, more air is drawn into the low-pressure air cylinder through the air strainer and the inlet valve *10* to make up for the amount that is taken out. Both pistons are now in the upper ends of their cylinders and both cylinders are filled with air at atmospheric pressure. The low-pressure air piston then starts down and compresses the air beneath it into the high pressure air cylinder and at the same time air is drawn into the upper end of the cylinder through the air strainer and the upper inlet valve *9*. The high-pressure air piston next moves down and forces the air through the lower discharge valve *14* into the main reservoir. At this time the compressed air holds the intermediate discharge valve *12* to its seat and prevents the return of the air to the low-pressure air cylinder. The downward movement of the high-pressure piston draws air through the intermediate discharge valve *11* from the low-pressure air cylinder which, however, is kept replenished through the air strainer and the upper inlet valve *9*. The low-pressure air piston then moves upwards and the operations just explained are repeated.

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